JUL 1 1940

CIVIL ENGINEERING

Published by the American Society of Civil Engineers

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President

Volume 10 — Number 7

JULY 1940

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Among Our Writers

M. G. SPANGLER (Iowa State College, 1919; M.S., 1928) served as bridge designer with the Iowa Highway Commission for 5 years prior to joining the research staff at Iowa State College. His principal research contributions have been in the field of loads and stresses.

ENOCH R. NEEDLES (Missouri School of Mines, 1914; C.E., 1920) joined the staff of Harrington, Howard and Ash, consultants in bridge design and construction, in 1917. Since 1928 he has been a partner in the firm of Ash-Howard-Needles and Tammen.

C. F. RASSWEILER (Ph.D., U. of Illinois, 1924) has been with E. I. du Pont de Nemours and Company since 1924—first in the experimental station at Wilmington, Del., and from 1927 on in the Philadelphia Laboratory of the Fabrics and Finishes Division—since 1933 as director.

ARTHUR B. DAVIS has spent over 25 years in the service of the Virginia Bridge Company. He was contracting engineer in charge of the New Orleans sales office from 1922 to 1926, and has been manager of the Memphis plant since March 1926.

FREDERICK H. DILL (Rutgers U.) has been employed by the American Bridge Company since 1929—recently on technical and shop problems connected with the use of welding and "flame" processes for structural fabrication.

F. C. HUTCHISON (Mass. Inst. of Tech., 1927) was employed by the Linde Air Products Company following his graduation. Since 1932 he has served as engineer in process service work for that organization.

RUSSELL G. CONE (U. of Illinois, 1922) was resident engineer on the construction of the Philadelphia–Camden Bridge, the Ambassador Bridge at Detroit, and the Golden Gate Bridge. Upon completion of the latter structure, he became engineer for the Golden Gate Bridge and Highway District.

S. J. CALLAHAN (U. of Missouri, 1914) was for 12 years engaged in the design of concrete and structural steel buildings in the Kansas City territory, and for the past 6 years has supervised the construction of bridges and buildings being built under the Kansas City Ten Year Bond Program.

F. W. MEDAUGH (Vanderbilt U.) has had 8 years of experience in railroad engineering and 18 years of teaching experience. At present he is teaching surveying and hydraulics at Johns Hopkins.

G. D. JOHNSON has just received his master's degree from the Johns Hopkins University. Since February 1937 he has been employed in the engineering department of the S. Morgan Smith Company, of York, Pa.

MARCEL GARSAUD (Tulane U., 1903) has been with the Orleans Levee Board (chief engineer), the Dock Board of New Orleans (general manager), and the Federal Power Commission. Since 1932 he has had a consulting practice in Jersey City.

WENDELL P. BROWN, in nearly 50 years of engineering work, has been connected at various times with the construction or design of some 6 movable bridges in Cleveland alone, and others elsewhere. He was recently honored with a citation by the Cleveland Society of Professional Engineers for "distinguished engineering contribution to the public welfare. . ."

CECIL E. PEARCE (Stanford U.) was with the Los Angeles County Flood Control District in 1927 and 1928. As chief design engineer on the Morris Dam and Aqueduct (1928 to 1934), he developed mathematical theories for earthquake-resistant designs. In 1934 he joined the staff of the TVA.

CHARLES M. NOBLE (Columbia U.) has worked in the Alabama, Kentucky, and New Jersey state highway departments, and was with the Port of New York Authority from 1925 to 1938. In the latter year he became connected with the Pennsylvania Turnpike Commission.

J. L. BARRON (U. of Kansas, 1923) was with the Kansas Board of Health for 6 years and was sanitary engineer of Westchester County (N.Y.) for 8 years. Since 1938 he has held a similar position in Nassau County (N.Y.).

F. B. FARQUHARSON (U. of Washington, 1923) joined the faculty at that university in 1925 and is now in charge of courses in mechanics of materials, the Photoelastic Laboratory, and the Structural Models Laboratory. He is at present engaged on dynamic model studies for the Tacoma Narrows Suspension Bridge.

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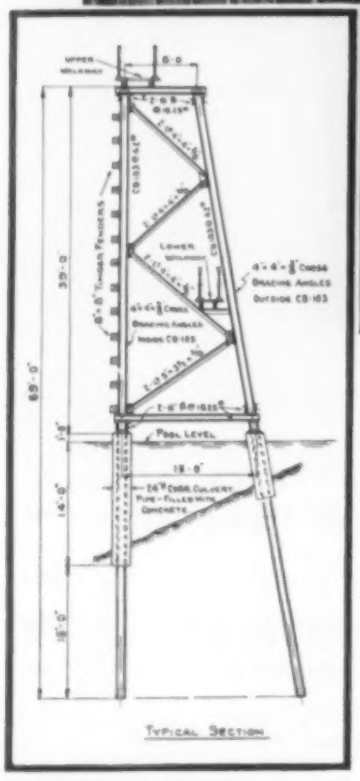

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

What Is Engineering Research?

By M. G. Spangler

Associate Member American Society of Civil Engineers
Research Associate Professor, Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa

ONE definition of the word "research" is given as the effort to find new information in history, science, literature, or the like, by experiment or by thorough investigation of sources. I was somewhat amused to note while looking up this definition that the word itself is derived from the latin *re* meaning again, and *circare*, to go around. Many times in my work I have been vaguely conscious of going around in circles, apparently getting nowhere, but I did not realize that, literally speaking, this activity constituted research.

To the layman the word research often connotes a form of magic. He is apt to think of a researcher as a sorcerer who secludes himself in a laboratory filled with mysteriously coiled glass tubes, retorts, and miscellaneous gadgets, from which he emerges to present the world with some new device or process that will revolutionize our way of life. It is true that research has revolutionized civilization many times over, but these results have been attained by the slow process of accretion—the hard way—and not by any type of magic.

Learning to Fly.—I know of no more thrilling or more typical example of this fact than the research which led to the construction of the first successful airplane. Man has always wanted to fly through the air, to imitate the birds. However, it was not until the beginning of the nineteenth century that navigation of the atmosphere in heavier-than-air craft was seriously suggested. Sir George Cayley at that time envisaged a rigid plane mechanism driven through the air by propellors connected to an efficient source of mechanical power. He even suggested the application of the internal combustion engine to aircraft, but little heed was paid to this hint, since at that time steam power was so much cheaper and the advantages of light weight for airplane engines were not fully realized.

Heavier-than-air navigation remained dormant for nearly forty years, when Henson, another Englishman, obtained a patent for an "aeroplane" for mechanical flight. He and several contemporaries formed a company to exploit the patent, but could not raise the necessary funds and had to content themselves with the construction of models, several of which flew successfully. During the half century after Henson, the contributions to this new science became more frequent and we find many names on the list of those who added a bit of knowledge—a thin layer to the pearl of great price which was in the making.

An immortal name in the annals of flight research is that of Otto Lilienthal, a German engineer, who contributed immeasurably to the theory and practice of stability of heavier-than-air machines by his extensive experiments with gliders. He achieved a remarkable degree of stability control by expertly varying his body position, and was about ready to begin work on a power-driven ornithopter when, while trying out a new type of horizontal rudder control mechanism, he became confused and nosed his glider down instead of up and fell about 50 ft, suffering a broken back, from which he died twenty-four hours later.

Contribution by a Civil Engineer.—An important link between Lilienthal and the Wright brothers was Octave Chanute, elected president of the Society in 1891. Chanute watched Lilienthal's work closely and aided materially in disseminating the latter's results in the United States. He believed, however, that Lilienthal's best machine was hazardous because it depended upon alteration of the rider's body position for stability control. Chanute advocated that some mechanical method of control be devised, and began glider experiments of his own at the age of 60. Despite his age he had considerable success, developing his controls to the extent that he could entrust his machines to amateurs.

Thus the stage was set for the entry of the Wright brothers, who were stimulated to speculate on the problems of flight by news of the death of Lilienthal in 1896. After four years of study, they began experimenting with tethered kites. Seated one day in their bicycle repair shop in Dayton, Wilbur idly twisted the top of a box which had contained an inner tube. There arose in his mind the idea of warping the wing of a plane to obtain stability and this idea became the basis of their success. They kept improving their machines until, in September and October 1902, they made nearly

a hundred successful glides and gained invaluable experience by many minutes in the air.

Triumph at Last.—Following these successful flights in gliders, in the winter of 1902 they turned definitely to the construction of a biplane, powered with a four-cylinder gasoline engine which developed 16 hp and drove two propellers by means of bicycle sprocket chains. After many minor delays incident to launching, Orville Wright actually flew this machine a distance of 120 ft shortly after 10 o'clock on the morning of December 17, 1903. Three other flights were made later that day, the last one being for a distance of 852 ft by Wilbur. Thus after a long period of gestation, the navigation of the air in heavier-than-air craft was born, and mankind was presented with a new medium of transportation, which even now, 36 years later, is in its infancy. The essential point of this story which I wish to emphasize is that this remarkable feat was not the accomplishment of the Wright brothers alone, but rather it was the culmination of a long series of speculations, calculations, and experiments, dealing with the equilibrium of forces and pressures and the development and application of power—very decidedly engineering research.

A similarly thrilling story could be told about many of the other fruits of engineering research—the radio, the steam engine, fuels for internal combustion engines, audible motion pictures, non-corrosive metals, and a host of others—and in each case it would be apparent that the solution of the problem came about as the result of the contributions of a large number of researchers, each adding his bit of new knowledge to that already discovered.

A Dream Materializes.—Now what are the elements of engineering research that are illustrated by the story of the development of the airplane? First of all, someone had to have the desire to fly, and we may accept as axiomatic the statement that all engineering research is founded upon the desire of mankind to attain a higher level of accomplishment in the composite arts and sciences which we call engineering.

Next, it is necessary for someone to outline the general idea by which these betterments may be accomplished, just as Sir George Cayley envisaged the power-driven airplane. Such ideas may be very crude and impractical when first expressed, and yet a beginning must be made somewhere. Ideas are the raw materials which are processed to produce the fruits of engineering research.

When the desire and the ideas for attainment of the desire have been formulated, the actual work of the research worker begins. By the application of logic, by experiment, by trial and error, or even by intelligent guesswork, he seeks to contribute some bit of original knowledge to the subject of his research. Gradually, by the accumulation of these contributions from many sources, the problem yields to solution. It is rare indeed that one man or one research organization discovers all the knowledge required to solve a problem.

Personal Qualifications Spell Success.—Some may wonder what type of person is fitted for research and that is a fair question. Well, frankly, the people whom I mentioned as having contributed to the science of aeronautics were judged by their contemporaries to be crazy. The story is told that on one occasion when Chanute was visiting at a friend's home, he was asked what his hobby was. Rather embarrassed, he said he would rather wait until the friend's children had gone to bed before discussing it. After the children had gone, he confided that his hobby was flying machines, and he was afraid the children would think he was crazy if they heard him speak of it. When he actually made his gliders, he went deep into the sand dunes along the southern end of Lake Michigan to avoid attracting public attention. Likewise, the Wright brothers avoided the public gaze as they would the plague, and it was not until several years after their first successful flights at Kitty Hawk that the newspapers got hold of the story. The experiments of Langley, a contemporary of the Wrights, were performed with public funds and he could not readily avoid publicity. He was scored unmercifully in the press as a madman.

I am not prepared to say that it is necessary to success for a research man to be crazy, but some of the characteristics which led the world to think these men insane are prerequisite to the research mind. For example, a researcher is not afraid of a new idea, whether it is his own or comes from someone else, and he should be the last person to ignore or ridicule an idea just because it has never been thought of or carried out before.

Some Traits That He Needs.—He must possess more than the ordinary amount of imagination and be able to see with the eye of intelligence that which is not yet available to others in black and white. He must be intellectually curious and never take too much for granted. He must have the courage to travel uncharted paths even when assailed by the doubts and, too often, the ridicule of others who cannot see the path as well. He must be persistent to the point of stubbornness, must have infinite patience, and be prepared to meet failure cheerfully. Things go wrong so easily and experiments in new fields so often turn out to be fruitless that the researcher must keep a stiff upper lip and painstakingly study his procedure to determine where it is wrong and how to remedy it—secure, however, in the knowledge that each failure will yield a new crop of ideas, one of which may lead the way to success.

Also he must learn not to expect results too quickly. One of the most difficult lessons for a young man in research to learn is that knowledge cannot be discovered and new problems solved on a mass-production or assembly-line basis. Furthermore, this same lesson must be learned by the administrator of a research organization. He must be able to discern between purposeless bungling and persistent, intelligent groping. The two look distressingly alike at times. Fortunate indeed is the research worker whose superior has himself done enough research to realize the inevitably slow pace at which basic knowledge is discovered.

Exemplifying Research.—I like the philosophy expressed by Chanute, who wrote in 1897: "The successful flying machine will, in my judgment, be worked out by a process of evolution; one experimenter finding his way a certain distance into the labyrinth, the next penetrating a little further, and so on, until the very center is reached and success is won." That, in my opinion, epitomizes engineering research.

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VOLUME 10 — JULY 1940 — NUMBER 7

Preparing Structural Steel Surfaces for Painting

A Symposium on Methods of Preventing Corrosion in Shop and Field

THIS symposium, presented before the Structural Division at the Society's Spring Meeting in Kansas City, Mo., on April 19, 1940, is a real contribution to our understanding of corrosion in structural steel and of present methods of cleaning it and protecting it with paint. There is much confused and contradictory thinking as to the cost and practicability of sandblasting. Wire-brush and hand methods have proved expensive and inadequate, and chemical pickling is too costly. However, flame cleaning to remove mill scale, a recently developed process, seems to provide a satisfactorily clean surface at reasonable price, and shop primers composed of certain synthetic resin vehicles, and corrosion-inhibiting pigments, give promise of supplying adequate surface protection. Equally important, sandblasting to prepare steel surfaces for painting has proved both economical and practicable, as well as efficacious, under certain conditions, and may prove much more appropriate than has been generally accepted heretofore. In the field, the flame method is used to ensure the moisture-free surface so necessary for paint adherence.

Corrosion—the Structural "Common Cold"

By ENOCH R. NEEDLES, M. AM. SOC. C.E.
ASH-HOWARD-NEEDLES AND TAMMEN, CONSULTING ENGINEERS, NEW YORK, N.Y.

OF all the ills to which civilized man is subject, the "common cold" is probably the most common, the greatest nuisance, and the one most taken for granted. We are inclined to accept the "common cold" as a necessary evil, about which we can do little, and the medical profession not much more. Our medical experts cannot be too well pleased with the inadequate results of their long-continued efforts to prevent or even control the ravages of this simple illness. The "common cold" is indeed so common that we scarcely think of it as a disease; and still every year this enemy of man is responsible for incalculable economic loss in addition to physical distress, undermining our strength and resistance and frequently making us easy prey to more serious illnesses.

Structural engineers have a problem to cope with which is quite comparable in their field to that of the "common cold" in the medical field. I refer to the rusting or corrosion of structural steel, and our inadequate efforts to control, reduce, or prevent it by the use of paint. Structural engineers take pride in the exactness with which they investigate stress distribution, the economic proportioning of members and joints of structures, the precise manufacture and fabrication of parts, and finally the erection of an elaborate structure with assurance and control in every detail. We have a remarkable list of successfully completed skyscrapers, bridges, and other complex structures, with economy of materials and money, with maximum safety and utility, and with minimum risk and loss. Nor do we forget esthetics. More and more our structures are becoming truly beautiful, in conception, in line and form, as well as in purpose.

SERIOUS ECONOMIC LOSSES DUE TO CORROSION

If ever we have had an abomination to contend with, however, it has been this matter of corrosion and painting. Our national economic losses each year due to the corrosion of steel are real and tremendous, and we cannot be very proud of our efforts to prevent them. Such efforts to date present a spectacle of uncertainty, futility, and ignorance which is strangely out of keeping with the beauty and certainty of our calculations, our fabrication, and our erection.

We are concerned here with painting for protection, and in this symposium are making a concerted and intelligent attack on the general subject of prevention of corrosion. Our metallurgists and steel manufacturers have given us stainless steels but these are not yet economically available for major structures. Some day American structural engineers will undoubtedly be furnished with a non-corrosive structural steel; but that day may be far away and in the meantime the problem of corrosion must be dealt with. Our chemists and research people have made notable advances in recent years toward a more truly permanent and enduring paint for commercial use on structural steel; but surely we have not secured a perfect or foolproof paint as yet.

Ash-Howard-Needles and Tammen, Engineers

NATCHEZ BRIDGE, NATCHEZ, MISS., ON JUNE 6, 1940
Steel for River Spans Was Flame Cleaned by Bethlehem Steel Company. Specifications Required Either This or Sandblasting

Some of the practices and some of the results of our steel painting in past years and even of the present time have been most inconsistent, quite astonishing, and in many cases rather ridiculous. The paints are of all kinds and flavors, some dating back to the dark ages in composition and preparation, and some representing the latest attempts at scientific developmen. Some engineers are satisfied with a paint costing 60 cents per gallon and other engineers insist on paint costing from three to four times as much. Some engineers are satisfied with steel cleaned for painting by the most slipshod hand methods, and others insist on sandblasting down to bright metal. One method of cleaning may cost 75 cents per ton; the more careful methods may cost several times as much; and the advocate of each method may consider his practice economically sound. Some engineers contend that little or no cleaning of steel is desirable before shop painting, relying on maintenance painting to remedy any weaknesses in the paint film which may develop from loosening mill scale or corrosion. Other engineers may contend that the steel should be "weathered" for several months to loosen the mill scale before cleaning for the shop coat. Some engineers are doubtful about the importance of rust inhibition in shop paint and desire a more weatherproof shop paint; others are convinced that a shop paint must be rust inhibitive, and that this quality should not be sacrificed for weatherproofness.

There are all sorts of pigments and inert materials used in paints and all sorts of vehicles for these pigments. There are some engineers who believe they have a formula for the manufacture of paint which any manufacturer can furnish equally well under proper inspection; and there are other engineers who believe that making paint may be something like making a cake. The young bride may buy the finest ingredients and follow the best recipe in the newest cook book, but she may not produce at first a cake quite as good as her mother. These latter engineers may also believe that the finest formulas for paint are not available to structural engineers, but are possessed only by paint specialists and research chemists. Some engineers insist that the paint manufacturer shall have a reputation and stand behind his product in some responsible way, while others consider this of minor importance.

Then we have the paint salesmen. All of them are glib and gracious and well garbed and most of them will tell the engineer anything he wants to hear, and possibly take him any place he wants to go. If you listen to the usual paint salesman and read the customary literature put out by paint manufacturers, you will hear the same story over and over again, always told in superlatives and always claiming perfection. There is never anything wrong or anything lacking in any paint the usual salesman brings. He always claims perfection and has the cure-all for painting troubles. Most of these fellows are mighty agreeable, even if most of what they usually say isn't true. They may make the engineer's life gayer, but not any simpler.

Some engineers are not so particular about the class of labor that cleans the steel and applies the paint. Others insist on selected workmen with competent superintendence. Some engineers prefer to apply paint by spraying; others insist that only brushing be permitted. Some specify their red lead shop paint to be so heavy that it may be only a few degrees short of a paste. Others appear willing to allow so much vehicle to be added that the result looks like brick-dust and oil—and acts like it. Some engineers are agreeable to allowing the fabricator to mix his own shop paint pretty much to suit himself. Others prefer to insist upon the use of proprietary brands of shop paint in sealed containers of the manufacturer.

PAINT ADULTERATION AND SKIMPING TO BE AVOIDED

One situation that is not at all uncommon, but particularly difficult for the engineer, is where the fabricator or erector sublets the painting work to a subcontractor at the lowest bid price, the paint to be bought by the erector and charged against the subcontractor. Of course the specifications may be very strict as to methods and may call for paint of the highest quality, but the situation becomes very complicated if the subcontractor has bid too low, and has a smart foreman on the job working on a bonus basis. The temptations and opportunities for paint adulteration and skimping are

innumerable. The paint may last until a few months after the contractor is finished and paid. Then, when the paint fails and trouble comes, try to find the answer. The owner asks his engineer; the engineer speaks to the fabricator or erector, who in turn washes his hands of the matter by calling on the painting subcontractor. This gentleman asks you to talk to the paint manufacturer about your troubles, but the manufacturer insists that the paint was perfect when it left his plant. The owner has to pay for reconditioning the paint much more quickly than his engineer told him he would, and the engineer tries to hide his embarrassment. The spectacle is one which does our profession no credit.

We have many fine examples of cases where bridges over fresh water have gone from seven to ten years or more before repainting work of any consequence was required, where only ordinary methods of cleaning and application were used with moderate priced paints. On other structures, with conditions almost identical or equally favorable, seemingly, we find serious paint failure in one or two years. In some cases of major importance, we find the shop coat in excellent condition for field painting after erection, and in other cases a very expensive job of recleaning and reapplication of shop paint in the field must be undertaken before field painting can be permitted.

We have seen newly painted steel begin to show film failure and corrosion within three to six months when it was close to salt water and subject to salt spray or ocean fogs. We have seen serious deterioration of paint from industrial gases or dust or acid under conditions we did not know to exist before the structure was completed. We have seen loosening of the paint film from beneath rather than failure from the outside, presumably due to a progressive loosening of the mill scale, or from corrosion due to electrolysis, or because of a permeable or porous paint film, or a combination of these.

Many of us have had bitter experience with structures where the effort toward maintenance of paint and control of corrosion was something like trying to control an epidemic of influenza. The continued paint failure and the cleaning, scraping, and repainting seem endless. These renewal operations are repeated in part year after year, sometimes improving conditions, other times apparently not—with a steady and very unpleasant drain on the owner's pocketbook. In such cases the cheapest and wisest plan undoubtedly would be to clean off all rust and paint back to the raw steel, and repaint the entire structure in a single operation, but seldom are sufficient funds available for such a major job.

Apparently the structural engineer is becoming convinced of the need of a clean, dry, and relatively warm steel before the application of a shop paint. The paint must be applied smoothly and uniformly to secure a firm and impermeable film. The paint itself should discourage rather than encourage corrosion. The outer paint coats should be as durable and weather-resistant as possible. We should know more about how to prepare steel surfaces economically for painting, whether by mechanical devices, sandblasting, flame cleaning, or otherwise. We should know more about pigments, and about vehicles, whether of the linseed-oil type or of the synthetic type.

The proper and thorough cleaning of steel in advance of the first shop painting is one of the most important steps in the entire painting procedure. The old hand-cleaning methods are inadequate and should be abandoned. The best mechanical devices for cleaning today are not what they should be. As between sandblasting and flame cleaning, either can be highly acceptable. Sandblasting to blue steel, not bright, should meet every need. During the past year we have had some splendid examples of sandblasting and flame cleaning on large tonnages of structural steel. The shop paint applied on this steel shows evidence of giving a greatly improved service record. We should give very great credit to the fabricators who have produced these results. The new high-quality, synthetic-resin-vehicle paints are a notable improvement over the old linseed-oil paints. Not many of us who have had reasonably extended experience with the best synthetics properly applied would go back to the oil paints through choice.

We should reach reasonable agreement on the cleaning and painting methods that should be used, and the character and quality of the paints that should be required. We need a common determination on the part of engineers, contractors, and manufacturers to require better and more uniform results. We need an improved system or procedure for cleaning and painting, with responsibility for results placed upon the proper shoulders without opportunity for shirking or equivocation. We need painting contractors who will guarantee their painting jobs for two years, for five years, or even longer.

This symposium is a start toward a common understanding of how best to prevent or at least to control the structural engineer's "common cold."

Steel Corrosion—Its Nature and Prevention

By C. F. RASSWEILER

DIRECTOR, PHILADELPHIA LABORATORY, E. I. DU PONT DE NEMOURS AND COMPANY, PHILADELPHIA, PA.

IN considering the problem of protecting steel structures from corrosion, the effectiveness of surface preparation and the effectiveness of shop priming are so interrelated that they should always be considered as two parts of a single procedure. Together they represent the work that must be done in preparing a steel surface to receive the topcoats of paint designed to withstand the weather. Once the structure is erected, very little can be done to correct any errors or omissions in the initial cleaning and shop priming. The nature of the weather-resisting coats can be changed almost at will, but no matter how durable the topcoats are, corrosion will continue under the film if the steel was not properly cleaned and primed originally.

This article will discuss some of the general principles covering what a shop coat is supposed to do and the mechanism by which some of the more common types of shop primers attempt to achieve this objective. An appreciation of the factors underlying the performance of shop primers will help to clarify the importance of cleaning the steel before the shop primer is applied.

THEORY OF CORROSION OF STRUCTURAL STEEL

Iron combines with oxygen to form iron oxide. Under certain oxygen concentrations this combination takes place so rapidly that an iron wire in a test tube, for example, will actually burn like a piece of wood. At ordinary temperatures and oxygen concentrations, this

combination of iron and oxygen takes place very slowly if at all, unless water is present, but when water and oxygen act together the iron on the surface is converted

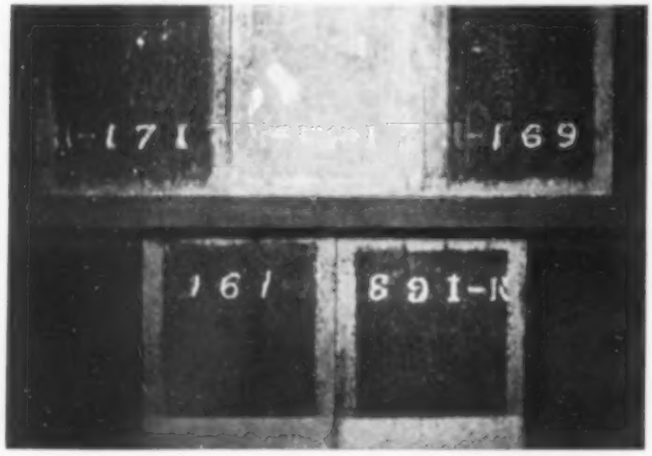


FIG. 1. INHIBITIVE VALUE OF PIGMENT IN SHOP PRIMER
Samples Exposed Seven Years at 45° Angles, Facing South, in Florida. Dark Color Shows Corrosion. Upper Center, Red Lead Pigment in Oil Vehicle Under Standard Oil Topcoat; Other Panels, Representative Natural and Synthetic Iron Oxide Pigment in Oil Under Same Oil Topcoat

quite rapidly into hydrated iron oxide, commonly recognized as rust.

The rate at which this reaction takes place is greatly affected by a large number of secondary factors. Most of the theories of corrosion deal with the importance of these secondary factors and the mechanism by which they promote or inhibit corrosion. Almost all these theories, however, are built around the basic assumption that when the steel surface is wet with water, tiny electrical cells are set up as a result of differences in potential between different points on the steel surface. The surface film of water serves as a conductor through which the minute electrical currents flow between these points of differing potential, causing the iron to go into solution where it reacts readily with water and oxygen to form hydrated iron oxide. The rate and extent of corrosion therefore are affected by changes in composition and structure of the steel or by the nature of the corroding elements acting upon it.

Any factors that tend to reduce or destroy the difference in potential between different points on the steel surface or to increase the resistance to the flow of current between these points, will retard or inhibit corrosion. For example, if salt is added to water, the rate of corrosion becomes more rapid. This is because the salt increases the conductivity of the surface layer of water, and the decomposition products formed by the action of the current on the salt increase the tendency of the iron to go into solution, where it is readily oxidized and hydrolized to rust. On the other hand, we know that if we put potassium dichromate in the water that is in contact with the steel, corrosion is inhibited or prevented; that is, the steel is made passive, presumably by the polarization of the terminals of the tiny cells on the steel surface, with the result that the electrical current is shut off.

RUST INHIBITION AND HOW OBTAINED

With this simple picture of corrosion in mind, we see that the ideal way to prevent corrosion would be to completely prevent water and oxygen from reaching the steel surface. No practical paint coatings so far produced achieve this ideal condition. Paint coatings vary in their permeability to water and gases, but none even approach complete impermeability. A shop or priming coat of paint, first, must retard, as far as possible, the approach of water and air to the steel, and second, must create conditions at the steel surface that will inhibit the reaction of the invading water and oxygen with the iron, either by keeping the steel surface in a "passive" condition or by preventing the water from setting up a continuous conducting film on the steel surface.

FUNCTION OF THE PAINT PIGMENT AND VEHICLE

Any paint is composed of two components, pigment and vehicle, the pigments being simply dry powders and the vehicles being the liquid materials that gradually dry to tough, adherent films and cement the pigment particles together and hold them on the surface. The ability of a shop coat to prevent corrosion is affected both by the nature of the pigment and the nature of the vehicle, and frequently by rather complex reactions between the two. It is frequently difficult to distinguish between the effect of the pigments and the effect of the vehicle, but a tremendous amount of research work has been done in correlating the practical performance of shop coats with their composition and their chemical and physical properties.

In particular we know a great deal about the factors that control impermeability, and a great deal of study has been given to developing paint coats that are highly resistant to the passage of moisture. Water, in penetrating a paint film, goes through the vehicle, not the pigment. The passage of the water can be retarded by mechanically crowding the pigment particles in the film, but the nature of the vehicle itself is the controlling factor in film permeability. Great strides have been made in decreasing the permeability of paint films to water through the introduction of synthetic vehicles. This is illustrated in Table I, comparing the permeability to water of linseed oil in comparison with a more modern synthetic vehicle when pigmented with common metal protective pigments.

TABLE I. WATER PERMEABILITY OF TYPICAL FILMS WEATHERED ONE MONTH
In Milograms of Water per Square Centimeter per Hour at 3 Mil Thickness of Paint

VEHICLES	PIGMENTS	
	Red Lead	Iron Oxide
Raw linseed oil	0.15	0.30
Long oil alkyd	0.07	0.10

Almost any of the new-type so-called synthetic priming coats, whether of the alkyd, varnish, or phenol formaldehyde type, are superior to older oil-type priming coats in resistance to the passage of moisture when applied at equal film thickness.

The resistance of a priming coat to the passage of moisture, however, is directly proportional to the film thickness. Therefore the practical effectiveness of a priming coat, when applied by practical means on rough structural shapes, must be measured in terms of the permeability of the thinnest spot in the film. Because most highly impermeable synthetic vehicles have exceptionally good flow, and therefore tend to flow away from high spots, many of them do not give good practical shop coats.

Even the most highly impermeable film would still be useless if it cracked or eroded away and exposed unprotected steel to the action of air and water. Most metal protective painting systems are based on the theory that the topcoats will protect the primer from the weather.

This permits the use in primers of pigments that have the highest possible inhibitive effect on corrosion, even though they do little or nothing to protect the vehicle from the destructive effect of sunlight. The pigments for the topcoat then can be selected from the viewpoint of protection against weathering without respect to their effect on inhibiting corrosion. A shop coat, however, must serve both functions, for it must carry the inhibitive pigments which for the life of the bridge will remain next to the steel surface, and at the same time it must be weather resistant enough to maintain its film integrity during the relatively long periods of exposure during erection, before the topcoats are applied. Sometimes both inhibitive and weather resisting pigments are included in a shop coat to secure compromise properties, but the direction of research has been largely toward achieving weather resistance by improving the durability of the vehicle and thus permitting the pigment to be selected purely from the viewpoint of its inhibitive effect.

However, even the most impermeable and durable shop primer does permit some moisture and oxygen to permeate the film. Hence it is important that full consideration be given to the second function of the shop coat, which is to create and maintain conditions at the steel-paint interface which will inhibit or prevent corrosion even though invading water and oxygen are present. The ideal would be to create on the steel surface a passive condition, such as exists when steel is immersed in a solution of potassium dichromate. The problem cannot be solved by the simple inclusion of a material like potassium dichromate, however, because such water-soluble materials gradually leach from the film and lose their effectiveness while reducing the film's durability. However, the same passive condition can be approached if pigments such as red lead, zinc chromate, or basic lead chromate, are used in the priming coat and if the priming coat is applied in direct contact with the steel surface. The difference in inhibitive effect between an active pigment like red lead and a neutral pigment like iron oxide is quite marked, as can be seen in Fig. 1, which compares the rust-preventing effect of a number of primers made from these pigments.

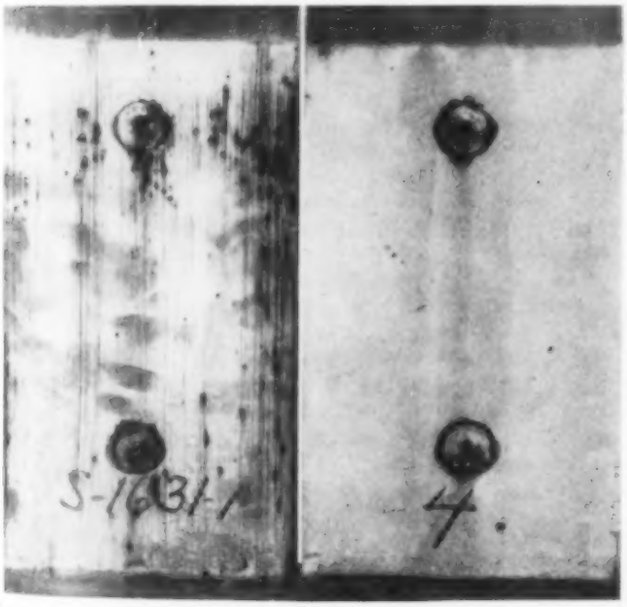


FIG. 2. PROTECTIVE VALUE OF SYNTHETIC VEHICLE IN SHOP PRIMER
Samples Exposed 2¼ Years at 45°, Facing South, in Delaware. Both, One Shop Coat Lead Chromate Paint. Left, Oil-Type Vehicle; Right, Alkyd-Type Vehicle

Highly technical electrical methods have been worked out to test the inhibitive effect of different pigments and to demonstrate that a true difference in the passivity of the steel is responsible for the difference in protective

FIG. 3. FIELD PERFORMANCE OF SHOP COAT USING ALKYD VEHICLE
One Coat Alkyd-Type Vehicle Primer Applied on Scale-Free Steel. After Two-Year Exposure to Severe Corrosion Conditions on Texas Gulf Coast Bridge, Only Isolated Spot Priming Was Required Before Applying Field Coat

effect. Most paint technologists agree in classifying such pigments as red lead, basic lead chromate, zinc chromate, zinc dust, and zinc oxide as inhibiting corrosion; iron oxide and most of the white pigments as being relatively neutral; and carbon black as a rust inciter.

HOW THE SHOP COAT PROTECTS

I believe that the shop coat acts to prevent corrosion not only by creating a passive condition on the steel, but also by the physical way in which it prevents the formation of the electrical cells that incite corrosion. The adhesion of a paint film is, to some extent, mechanical, but the primary adhesive force is the attraction between the steel and the paint surface. The scientist ordinarily speaks of these surface attractions as "wettability," and we say that the paint adheres to the steel just as water adheres to a piece of ground glass. As water penetrates through the paint film to the steel surface, it also has an attraction for the steel. The paint film and the invading water compete for the attractive forces on the steel surface. If the paint is of poor quality or if something has been left on the steel surface before painting that keeps the paint from direct contact with the steel, then the water will win, setting up the continuous water layer which creates the minute electrical cells that produce corrosion. If the adherence of the paint, however, is sufficiently good so that the water cannot displace it, and cannot set up a continuous water layer between the paint and the steel, then the resistance between the poles of these tiny cells is so great that little passage of electrical current takes place and corrosion is inhibited. The loss of grip by the paint on the steel may be temporary in nature, the paint regaining its original adhesion when the water dries out, or it may become permanent after continued or prolonged exposure. In either case the loss of adhesion will probably not be total and will probably be entirely unsuspected unless the paint is actually mechanically disturbed or subjected to severe dimensional changes as the result of temperature fluctuation, as when the paint falls off a galvanized iron billboard during a sudden freeze.

Tremendous strides have been made in producing shop primers that are more impermeable to water and gases,

more resistant to weather disintegration, and better able to retain their hold on the steel surface. Some typical examples of how well single coats of these shop paints have protected steel for long periods are shown in Figs. 2 and 3.

The oxide coating known as mill scale helps to protect steel as long as it remains continuous and adherent, for it is impermeable if unbroken and if it is adherent it prevents a water film from forming on the steel surface. On the other hand, it is easy to understand why so much early corrosion is associated with painting over mill scale. If the mill scale fails to remain completely continuous and adherent, then water permeating through the paint coat will collect on the steel surface under the loose scale, setting up corrosion cells. The paint cannot control this action because it is separated from the seat of corrosion by the layer of mill scale over which it was originally applied. Such failure is usually quite spectacular because the rust, having greater volume than the original steel which it displaces, gradually forces large chunks of mill scale and paint coating loose from the steel.

It is also easy to see how painting over rust or broken and partially corroded mill scale reduces the effectiveness of any shop coat or primer. To get any grip on the steel at all, the primer has to fight its way through the rust structures and into the fine crevices under the edge of the broken and corroded scale. All priming materials have certain penetrating properties, but they have a hard time trying to get through rust and into crevices that are full of trapped air. Since paints are all oily in nature, they cannot be expected to penetrate into cracks, crevices, or porous rust at all if water is already holding these places against them. A thin paint may penetrate into these places, but the film thickness that can be put on in one application is thereby decreased, and without an extra coat, involving extra cost, the thinning is likely to do more harm than good. It is also possible to help paint penetrate into rust and under scale by taking special pains to "work it in," but if extra money is to be spent to force the paint through the rust and under the broken mill scale, it would seem more logical to spend the extra money in removing the rust and scale before painting. When primers are applied over rust and broken mill scale, it is the vehicle that penetrates and the vehicle does not carry with it the inhibitive pigment. Therefore, what penetrating vehicle reaches the metal surface must fight its battle with the invading water, without the vital assistance of the inhibitive pigments paid for in purchasing the primer, but left behind, ineffective, on top of the rust or at the edge of the minute crevices under the loosening scale.

Steel surfaces must be so prepared that the paint will be in intimate contact with the steel or so that the only materials left between the paint and the steel will remain and exclude water themselves. To achieve this aim on large steel structures involves tremendous plant complications. It is an objective, however, which can be approached from a variety of angles, varying all the way from attempting to remove all interfering materials from the steel to applying some metallic oxide scale which will be so adherent that when protected with paint it will stay in place throughout the entire life of the structure. The structural steel industry is to be complimented on the intelligence and energy with which it is tackling the immense practical problems it faces in achieving the best surface preparation before painting.

The problem of corrosion and how to prevent it through the use of shop coating is much too big to be covered completely in this short article. There are an infinite number of tantalizing side discussions that might be followed if space permitted, and conflicting theories that might be quoted against the simple generalized statements here made. As a representative of the paint industry, I would like to offer the cooperation of that industry in working toward the goal of better shop priming.

Sandblasting as a Cleaning Method

By ARTHUR B. DAVIS, ASSOC. M. AM. SOC. C.E.
MANAGER, MEMPHIS PLANT, VIRGINIA BRIDGE COMPANY, MEMPHIS, TENN.

ACROSS the Mississippi River at Greenville, Miss. is now being erected the fifth bridge above the mouth of that river and the city of Memphis. It is a highway bridge, erected by the city of Greenville, to connect the rich delta lands of Mississippi and Arkansas. It will be a toll structure estimated to cost $4,000,000. It is expected to be opened to traffic during the late summer of 1940.

This bridge was designed by, and is being built under the supervision of, Ash-Howard-Needles and Tammen, consulting engineers of Kansas City and New York. The American Bridge Company was awarded the contract to furnish and erect the structural steel for the superstructure, amounting to 11,000 tons. To the Virginia Bridge Company they sublet a portion of the approach girder spans, on each side of the river, which amounted to 3,000 tons.

The specifications covering the shop painting and cleaning of the steel are quoted in part as follows:

"Before the application of shop paint, all metal work shall be thoroughly cleaned so as to be entirely free from all mill scale, to the extent removable by thoroughly sandblasting or by flame cleaning. . . .

"Cleaning of metal shall preferably be by sandblasting. Sandblasting equipment shall be effectively operated and sandblasting shall be continued down to clean blue metal. Paint shall be applied to surfaces sandblasted not more than two hours after completion of sandblasting. . . ."

The steel fabricated by the American Bridge Company at their Ambridge Plant was prepared for painting by the flame process. Because of having had some previous sandblasting experience at the Memphis Plant, and having had no experience with flame cleaning, we chose the sandblast method as the most suitable to our experience and facilities.

Most of the smaller bracing was sandblasted in a 50 by 50-ft steel building into which the pieces were taken on shop trucks after being loaded by an overhead crane. Immediately after cleaning they were returned to the yard, spread, and painted.

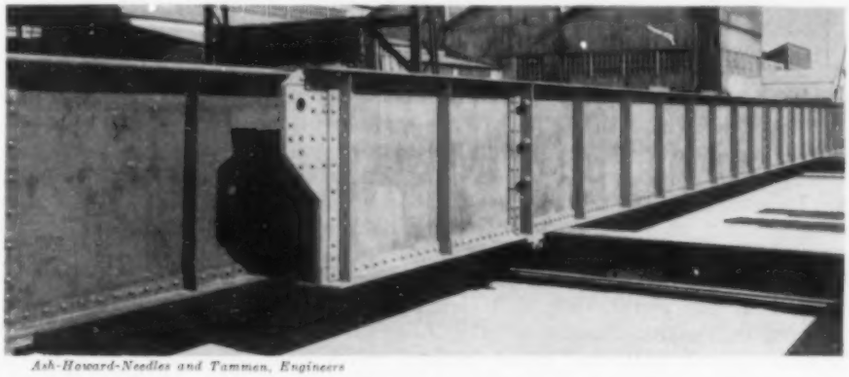
By weight the greater portion of the steel consisted of 270 plate girders 4 ft deep and 60 to 75 ft in length. To sandblast these, one end panel of our shipping yard runway was floored with a concrete slab 28 ft wide and 130 ft long. This slab had no weather protection, but

fortunately fine weather prevailed during the summer and early fall when the work was actually performed. Both the indoor and the outdoor work was done with a separate unit, each having a tank capacity of 1,350 lb of sand abrasive. The recovery of the sand for re-use was by hand.

Two operators worked simultaneously with each machine, discharging the sand through 1-in. hose equipped with $^3/_8$-in. cast-iron nozzles, and utilizing an air pressure of 80 to 85 lb per sq in. After several types of abrasives were tried, the most effective was found to be Ottawa silica sand and No. 7 flint abrasive.

The 12,607 separate smaller pieces handled indoors average 185 lb in weight and presented an average surface area of 272 sq ft to the ton. The 270 girders cleaned outdoors weighed $6^1/_2$ tons each on the average and involved 155 sq ft of surface area per ton.

The cost of the entire operation of cleaning the 3,000 tons ready for painting was approximately $1.50 per ton. Two operators cleaned the smaller items at an average rate of about 400 sq ft per hr; whereas on the girders, which presented continuous surfaces, the average rate was twice this, or 800 sq ft per hr. Immediately following the cleaning operation, and within the time required by the specifications, all steel was given the specified shop coat of paint which consisted of a red-lead priming coat of the quick-drying type.



Ash-Howard-Needles and Tammen, Engineers

TYPICAL APPROACH-SPAN GIRDERS FOR MISSISSIPPI RIVER BRIDGE AT GREENVILLE
Sandblasted Girder (in Front) and One Not Yet so Treated, in Memphis Plant of Virginia Bridge Company

Study of the specifications under which this work was performed—that "sandblasting shall be continued down to clean blue metal"—lead us to believe that they are most practical. They are specific, allow the work to be performed with reasonable cost control, and give the desired clean surface, free from objectionable elements, for the application of the priming protective coating.

MILL SCALE REMOVAL

In an article in the 1939 *Proceedings* of the American Toll Bridge Association, Theodore R. Hanff, stated that "by cleaning we mean the removal of all material, which, however well the paint may adhere to it, does not itself strongly adhere to the metal." He also points out that dust and dirt can easily be removed by ordinary means; that solvents will remove grease and oil; and that rust can be removed by ordinary hand scraping, wire brushes, or power-driven wire brushes.

The real concern is the mill scale, which Mr. Hanff describes as "a black scaly coating of oxide on the surface of rolled steel. It is an extremely hard, generally smooth, thin coating. It does not form an unbroken film over the metal but appears in patchy formation and of variable thickness. It generally very strongly adheres to the metal and has great resistance of itself to further corrosion. Because of these two properties of adherence and corrosion resistance, it would be a great asset if it appeared as an unbroken coating and much of our troubles would not exist.... It is not necessary to remove (tight) mill scale."

VARIABLE SANDBLASTING COSTS

Sandblasting costs vary widely, depending on the surface area to be treated. For example, Mr. Hanff points out that a solid sphere of steel 24 in. in diameter weighs one ton and has a surface area of but $12^1/_2$ sq ft. On the other hand, a ton of 3 by 3 by $^1/_4$-in. angles presents a surface area of 400 sq ft. While both examples involve one ton of weight, the angles present 32 times as much surface area as the solid sphere—hence the difficulty of dealing with this subject on the cost-per-ton basis.

Other features of the design, such as the capacity of the structure, will cause wide variation in the surface area per ton, and consequently in the cost of performing the work. Naturally, solid sections, like girders and beams, can be cleaned more economically than can latticed sections, which cause undue wastage of abrasive resulting in higher cost.

HAZARDS OF SANDBLASTING

Records of the National Safety Council for the past generation support the fact that industry has achieved remarkable results in accident prevention and in promoting the general welfare of employees along health lines. In this the engineering profession has played no small part. It should be noted in this connection that sandblasting is universally considered a very definite health hazard—the silicosis hazard. Our states are rapidly placing occupational diseases among compensatory items in employers' liability, and in some states sandblasting may even be forbidden by law. Our company took the precaution of making advance physical examinations of each employee working in the sandblasting gangs, of providing the best possible safety guards during exposure, and of making additional periodical checkups which included general physical and X-ray reports.

It is impossible to carry on painting near the sandblasting operation because of wind-blown sand. Extra handling and long transfers are required before paint can be applied to the cleaned pieces. Wind-blown sand and dust are difficult to keep out of bearings in machine parts, such as cranes. This creates heavier maintenance and repair costs.

Outdoor sandblast plants are useless in damp weather because the abrasive must be dry. Therefore, climatic conditions play a large part in successful and economical operation. Out-of-door operations also create problems regarding protection of the health of other employees on the premises as well as nuisances to neighboring industries. Specially designed, properly equipped buildings, with dust-control features to safeguard health, involve a heavy capital investment. This is especially true from the fabricators' standpoint when it is considered that by rule rather than exception single fabricated pieces often run from 50 to over 100 ft in length and weigh from 25 to over 50 tons.

After the sandblasting is finished, there is still a sizeable item of expense before the pieces can be painted, such as for removing secreted sand and dust. Paint must be applied within two hours to prevent incipient rusting. It is entirely impractical to clean contact surfaces by sandblasting prior to assembly and fitting; however, this is not essential as these closely contacted surfaces no longer present opportunities for corrosion.

The Flame-Cleaning Method

By FREDERICK H. DILL, ASSOC. M. AM. SOC. C.E.
AMERICAN BRIDGE COMPANY, AMBRIDGE, PA.

FLAME cleaning was introduced about a year and a half ago as a method of preparing surfaces of structural steel for their initial coat of paint. It has been developed since then as a process better suited to structural fabrication than the older processes of sandblasting, chemical cleaning, or mechanical cleaning. Flame cleaning utilizes relatively simple equipment but it permits the prime coat of paint to be applied on surfaces that are warm, dry, and cleared of rust and unbonded mill scale. Studies of paint and of corrosion of steel have indicated that paint applied under such conditions will stand up well in service.

CLEANING PROCESSES COMPARED

The older and better-known processes for cleaning steel prior to the application of paint or other protective coatings are of interest in comparison with this new flame-cleaning process because each of them has well-established procedures and certain unique characteristics.

Sandblasting can be made to effect complete removal of scale and rust from the surfaces of structural steel, but this is accomplished at some sacrifice of other conditions that are desirable in preparation for painting. The sand or grit used is driven into the crevices of assembled pieces, and it is almost impossible to remove all this "foreign material" prior to painting. It constitutes a weakness beneath the paint film because it is not bonded to the surface of the steel. If sandblasting is to be a routine operation in a fabricating plant, it must be established with permanent equipment under cover so that the dust arising from the work can be confined and so that weather will not interfere with production schedules. Such an installation must necessarily be elaborate and expensive. It will require that all pieces to be cleaned must be moved to the sandblasting location and then taken elsewhere for painting. As the pieces are usually large, cumbersome, and expensive to move, the operation is likely to become a "bottleneck" in the routine of production. Thus sandblasting, which is uniquely effective in some other industries, is unsuitable for structural fabrication.

Chemical cleaning methods, such as are widely used in the automotive industries for thin materials, have not been successful as a preparation for the painting of structural steel. These methods inherently require the use of water or water solutions, and the drying of this water from the steel after it has served its cleaning purpose is a serious problem. The large size of structural members and the thickness of their component material makes it impracticable to heat them sufficiently to dry all the water from their many surfaces and crevices. There is also a possibility that the cleaning solution may leave a residue on the surface of the steel which is not bonded to it and which is, therefore, an unsuitable base for the paint coat. Complete pickling of structural members would not alleviate these problems, yet it would require expensive installations of equipment and would be an expensive operation.

Mechanical cleaning, the process ordinarily used for structural steelwork, implies such operations as wire brushing and scraping, power brushing, or the various methods designed to break away scale, rust, and dirt by hammering. None of these procedures gets under the scale or its edges to lift it from the steel. They tend, rather, to push the scale against the steel because tools cannot be kept sharp enough to prevent them from "riding over" the edges of scale or other foreign matter on the surface of the steel. They are particularly ineffective in removing the thin films commonly found on steel rolled in some modern mills. The power tools used for mechanical cleaning are bulky and it is difficult to clean corners and complicated joints with them. Hand tools, of course, often lack the power necessary to clean effectively.

Flame cleaning of structural steel requires intense, high-temperature flames to be traversed over the surfaces to be cleaned so that they heat surface scale quickly and cause it to expand and free itself from the underlying steel before the steel is warmed enough to expand appreciably. This operation is followed by a thorough wire brushing, which breaks away any partially freed scale, dirt, or rust, and removes the freed material from the surface. The flame application and the wire brushing both create a considerable amount of fine dust, and this must be swept away before paint is applied because any large amount of it would prevent the paint from wetting the surface and it might even be considered a contaminant of the paint. The heat of the flames also warms the steel and drives moisture from its surfaces and from the crevices between assembled parts. Paint applied before the steel has cooled to the temperature of the surrounding atmosphere flows easily and forms a thoroughly adherent, uniform protective coating on the steel.

The flame, in contrast to mechanical methods of cleaning, has a "lifting action" which tends to raise exposed edges of scale and effect the removal of any that is not tightly bonded to the steel. The blistery type of scale, such as is usually found along the fillets of large beams, breaks almost completely free under the action of the flames because it is largely attached only at its edges. The free edges of scale patches or islands are curled up by the heat of the cleaning flames so that only the tightly adherent scale is left on the steel. The thin, almost glassy film which is found on many beam webs and wide plates, is not a true scale and is not much affected by the cleaning flames. It can be "pockmarked" by incipient fusion if the flames are traversed over it very slowly, but this is contrary to the process specifications and does not constitute flame cleaning. Mechanical cleaning methods, of course, are particularly ineffective in the removal of these thin films.

A primary consideration in the use of flame cleaning is its cost. It is an operation requiring the expenditure

of both labor and materials and it is inevitably more expensive than the ordinary cleaning and painting procedures. The process cannot be used economically, therefore, unless it creates real savings in subsequent maintenance. Such savings are generally attained only on major structures. Flame cleaning should not be specified promiscuously as a cure-all for the painting of all kinds of structural steelwork.

FLAME CHARACTERISTICS

The engineer who requires the use of flame cleaning must understand its essential elements and also the flame characteristics which make the process possible. Experiments have shown quite clearly that high flame intensity is most essential for flame cleaning. The intensity of a flame represents its ability to heat quickly and it depends on the inherent characteristics of the fuel gas and the manner in which it is burned. High flame jet velocity and, to a lesser degree, high flame temperature are simple indices of high flame intensity.

Comparisons of acetylene, propane, and hydrogen, the gases most commonly burned with oxygen, have been made to determine the value of each of them for flame cleaning. The basic characteristics of these three fuel gases and some comments on their usefulness are listed in Table I. It was observed in making these comparisons that the flames operating at high jet velocities were definitely more effective than slower flames. This phenomenon was especially evident in tests of various types of acetylene burners which all produced flames of the same temperature. Thus the early specifications for flame cleaning which demanded minimum flame temperatures of at least 6,000 F did not adequately specify the flame characteristics necessary for flame-cleaning work. More recent specifications, which have been approved by the American Institute of Steel Construction, require that "oxy-acetylene flames having an oxygen to acetylene ratio of at least one and a ratio of inner cone length to flame port diameter of at least eight" shall be used for flame cleaning.

The first of these requirements, that of an oxy-acetylene flame, is made to prevent the use of gases which may burn at a high jet velocity but which do not generate enough heat to warm the steel and prevent the condensation of the moisture generated in their combustion. The second requirement insures a flame temperature which is close to the maximum attainable with any oxy-gas flame. The third requirement is designed to insure adequate flame jet velocity and, since the energy of the flame is in part proportional to the square of this velocity, this requirement is a very important one.

Ash-Howard-Needles and Tammen, Engineers

MISSISSIPPI RIVER BRIDGE AT GREENVILLE, MISS.
Main Spans Were Flame Cleaned Prior to Shop Painting by American Bridge Company, Fabricators and Erectors

TYPES OF BURNERS

Some specifications for flame cleaning have prescribed the type of burners to be used, but experience with the process has indicated that such requirements are unnecessarily restrictive. It has been found, for instance, that extremely wide burners are not economical for cleaning assembled structural members because of the difficulty of manipulating them and the waste of gas which is inevitable in using them for cleaning flanges and narrow surfaces. As in the selection of paint brushes, there appears to be a practical limit to the width of burner which should be used. Comparisons between 6, 10, and 12-in. flat burners have indicated that the 6-in. width is the most economical and serviceable for general use. This size can be easily manipulated into corners, around rivet heads, and along narrow flanges without waste of gases, yet it cleans as well as a smaller burner. The

TABLE I. COMPARISONS OF ACETYLENE, HYDROGEN, AND PROPANE AS USED FOR FLAME CLEANING

Fuel Gas and Combustion Reaction	Approximate Flame Temperature of	Maximum Rate of Flame Propagation Ft per Sec	Comparison of Gases as Used in Equivalent 6-In. Flame-Cleaning Burners: Fuel Gas Used, Cu Ft per Hr	Heat Generated, BTU per Hr	Water Vapor Produced by Combustion, Cu Ft per Hr	Average Flame Jet Velocity, Ft per Sec	Remarks
Acetylene—C_2H_2 $2C_2H_2 + 5O_2 = 4CO_2 + 2H_2O + 3{,}000$ BTU	Max. 5,600 Aver. 5,400	46.5	100	150,000	100	475 to 650	Most intense and effective flames (*Increase in flame jet velocity shows marked increase in the flames' effectiveness*)
Hydrogen—H_2* $2H_2 + O_2 = 2H_2O$ Approx. 800 BTU	Max. 4,800 Aver. 4,650	29.0	200	80,000	200	270	Not as fast or as effective as acetylene (*Water vapor produced by the combustion condenses on cool steel*)
Propane—C_3H_8 $C_3H_8 + 5O_2 = 3CO_2 + 4H_2O + 2{,}500$ BTU	Max. 4,750 Aver. 4,650	12.5	80	200,000	320	160 (Counterbored flame orifices)	Slow in operation (*Flame does not heat scale without heating the steel beneath it*)

NOTE: Only 40 to 60% of the oxygen required for combustion is supplied through the burner. The remainder is taken from the surrounding atmosphere. The maximum flame jet velocity attainable with each of these gases is approximately proportional to the maximum rate of flame propagation for the gas.
* Commercial "hydrogen" is commonly adulterated with a hydro-carbon gas in order to make its flame visible enough for adjustment.

efficacy of the 6-in. flat burner has been proved by using it to clean an area which contained many rivet heads, stiffeners, splice plates, and fillers and then going over the surface again, after it had been wire-brushed, with a round type of burner specially made for cleaning places inaccessible to other burners. This second application of the flame did not accomplish any cleaning; all removable scale and foreign matter had been cleaned off by the 6-in. burner. Similar demonstrations also have shown that any re-application of the flames does not accomplish additional cleaning of the steel.

The above discussion is not intended to indicate that the 6-in. flat burner must be used for all work. Wider burners may be economical under some working conditions and there are many cases where narrower burners or round-type burners are better suited to the material to be cleaned. Recent specifications for flame cleaning require only that the individual flames of the burner "be not more than 0.15 in. center to center" and that "the number, arrangement, and manipulation of the flames shall be such that all parts of the surfaces to be painted are adequately cleaned and dehydrated." The engineer can thus demand results without specifying details of their attainment.

DETAILS OF FLAME CLEANING

It is important to recognize that the cleaning flames are not suitable for drying wet surfaces because they do not supply a large concentration of heat. They are designed and arranged only for quick, intense surface heating. The flames will not burn oil, grease, or paint off the steel being cleaned because of the slow rates of combustion of such substances. The flames simply flash their surface, but do not ignite them so that they will burn after the flame has passed. Even if such materials were burned there would remain an undesirable residue or ash which would have to be removed before paint could be applied. It is necessary, therefore, to wash oil, grease, paint and similar substances from the steel with suitable solvents before the surfaces are traversed by the flames.

The actual operation of the cleaning flames is relatively simple and it can be performed satisfactorily by the workmen usually employed for painting. The flames are adjusted so as to obtain the maximum length of neutral or slightly oxidizing inner cone which will stand steadily at the burner face without blowing off. The torch is held so that the flames impinge on the steel at an angle of 60° ± 15°, and the flames are traversed over the surface at a speed of 30 ± 10 ft per min. The acute angle of attack serves to blow freed material out of the way of the flames and it avoids direct reflection of the flames, which might heat the burner and interfere with its operation.

The wire-brushing which follows the application of the cleaning flames is roughly equivalent to the usual hand-cleaning preparation of steel prior to painting. Since the cleaning flames lift and free a large amount of scale, however, the brushing shows more marked results and is probably a somewhat easier operation. Old paint brushes are commonly used to sweep away the fine dust that remains after wire-brushing. These are soft and close bristled and they will clean out corners better than can be done by wiping with cloth, yet they leave no fuzz or threads on the rough edges which are characteristics of structural material. Compressed air cannot be used for clearing away the freed scale and dust because, even if it is dry, the chilling resulting from its expansion may cause condensation of atmospheric moisture on the surfaces being cleaned.

Many structural members are built so that some of their surfaces cannot be flame cleaned after the member is completely assembled. Ordinary hand cleaning methods are often adequate for such surfaces because they are not subjected to severe exposure in service. When flame cleaning is necessary, however, the surfaces which will subsequently be inaccessible should be cleaned of oil and grease, traversed by the flames, and wire-brushed but not painted before the member is assembled. After subsequent operations are finished, the exposed surfaces of the member should be flame cleaned and the previously cleaned surfaces should be wire-brushed or hand scraped, as may be necessary, before the member is painted.

SUMMARY

Flame cleaning is a fairly expensive operation, and it is by no means a panacea for all problems of painting structural steelwork. Steel which has been flame cleaned looks rough and almost pockmarked, especially in contrast to the uniform texture left by sandblasting or the brightened appearance which results from wire-brushing. Paint applied on flame-cleaned steel creates an impression, however, of being firmly and ruggedly adherent to the steel so that it will stand up well in service. In spite of the many observations and claims of merit for the flame-cleaning process, it must be remembered that it has not been in use long enough for anyone to determine its real value in increasing the service life of paint applied to structural steel.

Flame-Cleaning Apparatus

By F. C. HUTCHISON

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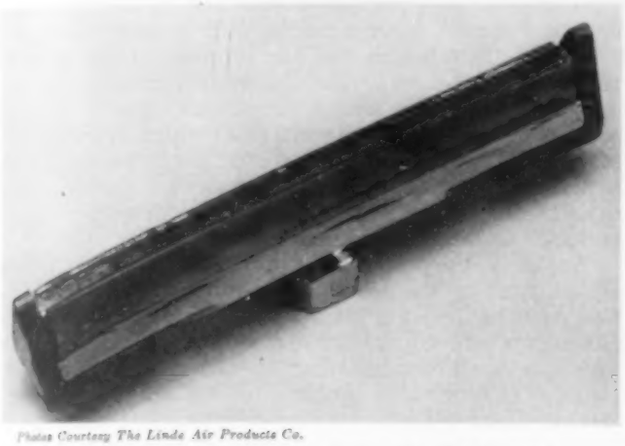
ACCEPTANCE of the flame-cleaning process by steel fabricators and engineers has been responsible for the development of a new line of oxy-acetylene equipment designed especially to meet the requirements of the process. These requirements are: (1) that the equipment operate under conditions of extremely high-heat-transfer efficiency, (2) that the heads be well protected against wear, and (3) that the equipment be light and easy to handle to minimize operator fatigue. The development of equipment to fit such requirements was part of a program started some years ago to create an improved method of treating scaled metal surfaces.

Flame cleaning and flame descaling are relatively new in the field of bridge construction, but for years cutting operators have used the flames of their blowpipes to descale the surfaces of steel plates in areas where cuts were to be made. In steel mills and forge shops, oxy-acetylene flame-treating equipment has been used to descale annealed forgings and castings. As a result of the

advantages and economies reported for such uses, flame-cleaning and flame-descaling apparatus have been developed since 1936 into the commonplace tools they are today. In extending the application of the process of descaling steel billets to the flame cleaning of structural shapes, three changed conditions had to be met: (1) the difference in the type of scale required a modification of the flame pattern; (2) the irregular shapes and the presence of rivets suggested enclosing the head in a wear-resistant case; and (3) the lightness of the head became a factor because of the many awkward locations of the surfaces to be cleaned.

The original investigation of scale formations had indicated the best flame characteristics for treating this

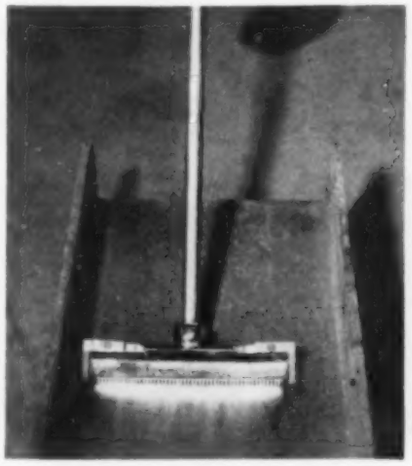


Photos Courtesy The Linde Air Products Co.

OXY-ACETYLENE FLAME-CLEANING HEAD, 6-IN. SIZE
Note Flame Parts, Hardened Skids, and Wear Pads

type of scale. The scale being a film-like coating rather than a thick brittle mass, the flames had to heat suddenly to produce differential expansion within the scale itself. Being thin and more tightly bonded, the flakes were removed in much smaller pieces and therefore the flames had to be more closely spaced.

Oxy-acetylene flames have extremely high temperatures, but in descaling processes the velocity of the flame jet is also of extreme importance in the transfer of heat. Steps were taken to increase both conditions to a practical maximum. The flame temperature was increased by using the heat picked up by the head to preheat the gases. The jet velocities were increased above those normally used, by developing specially designed and constructed flame-port orifices which permitted the flames to burn at velocities above normal without blowing off.



A 6-IN. FLAME-CLEANING HEAD IN OPERATION ON A 10-IN. CHANNEL

HEADS PROTECTED BY HARD ALLOY

On the flame face, ports are No. 75 drill size, or 20 thousandths of an inch in diameter, just a few thousandths of an inch larger than the smallest standard drill made. Despite their extremely small diameter, the flames are over a quarter of an inch long and each flame is uniform in size and shape compared with the others.

A TYPICAL OXY-ACETYLENE FLAME-CLEANING OUTFIT AT WORK ON A 10-IN. CHANNEL
Showing Cylinders, Manifolds, and Regulators

To protect the head from damage regardless of the position in which it might be used or of the surface it might be riding, hard alloy skids and wear-pads are placed as shown in the illustration. Each end is capped by a hard alloy casting which also serves to space the flames at the proper distance from the work. Running along the entire length of the head, on each side, is inserted a wear-pad of the same alloy, which curls up over the flame face, serving to protect the face from abrasion when drawn up over rivet heads or sharp edges.

Special doughnut-type heads for sliding down over rivet heads have been developed and tested by this single operation, but have been found to be unnecessary, as rivets may be cleaned with the standard head at a considerably reduced cost. As a further protection against damage, the head is equipped with a female blowpipe-connection which guards the gas-tight seat and the threads when the head is being taken on or off, or is being handled when disconnected.

In addition to being resistant to wear, the head is to a high degree resistant to flashing or popping. This is of considerable importance in flame cleaning when the flames are worked into corners and piles of loose scale. The long, high-velocity flames, although burning from very small holes, do not become shortened by clogging of the holes with flying scale. Whatever clogging might occur would come from foreign materials, which might enter the head by way of the blowpipe and hose. For cases such as this, a special clean-out plug is supplied at the end of the head, underneath the capped skid.

A typical flame-cleaning set-up is illustrated, including cylinders, regulators, hose, and blowpipe. Up to and including the blowpipe handle, the equipment is the same as would be used for welding. Pressures are low—acetylene should be set at roughly 4 lb per sq in. and oxygen at slightly over 30 lb per sq in. Higher pressures cause the flames to blow off and become ineffective unless throttled at the blowpipe. Under these conditions the flow will be in the range of 120 to 130 cu ft per hr. Three acetylene cylinders should be used for flows such as this in order not to exceed the recommended withdrawal rate. They should last for about a 7-hr flame time. Since neutral flames are used, the con-

sumption of oxygen and acetylene will be equal, and therefore four cylinders of oxygen will be used with every three of acetylene. However the oxygen cylinders need be connected only one at a time.

Apparatus manufacturers have shown that they are alert to the development of flame-cleaning equipment by applying the principles of flame treating, and have designed apparatus to fit specific customer problems.

Field Practice with Special Reference to Golden Gate Bridge

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A PROPERLY designed and well-constructed steel bridge should last indefinitely so long as it is not overloaded and provided that the members are not destroyed by corrosion. The original sections of the members must be preserved in order to retain the structure's load-carrying capacity. This therefore becomes the primary reason for painting. The life span of a steel structure thus depends on the protection afforded by paint.

"Obsolescence because of increased live loads" undoubtedly has been the excuse for the replacement of many structures that were in fact already partially destroyed by the inroads of corrosion. This excuse will not suffice for modern bridges designed for present-day stabilized loadings. Yet these structures are being attacked by rust and if not protected may be soon requiring extensive repairs. That painting failures on some of these modern bridges are resulting in heavy maintenance costs is now of enough importance to focus attention on the problem of corrosion prevention.

In the paint manufacturing industry materials have been steadily improved to meet competition from new paint substances. On the other hand, it has been only recently that the preparation of steel surfaces for painting received much attention. Experience with paint failures in the field has resulted in refinements of the specifications for several new structures to eliminate these failures. On structures now in service there is a trend toward scientific methods and greater care in the reconditioning of surfaces and in maintenance painting.

The paint film is attacked not only by various active agents in the atmosphere but also by corrosive forces between the paint film and the surface of the steel. The attack on the paint film from beneath can best be prevented by proper preparation of the surface before painting. Subsurface paint failures commonly are attributed to two principal causes: first, mill-scale loosening; and second, foreign matter such as moisture which prevented the adherence of the original priming coat to the steel. Mill-scale loosening is caused primarily by the presence of moisture within the porous edges of the mill scale. This moisture promotes rust, which lifts the mill scale from the surface of the steel, thus breaking the adherence of the paint film. On fabricated sections, this moisture is also present in the joints between the structural shapes that make up the member.

Therefore, the problem of surface preparation is further complicated by the additional requirement that the surface must be free of moisture at the time of painting. In climates where considerable moisture is present in the atmosphere, a conditioning operation in addition to cleaning is necessary. Paint films applied to moist surfaces in moist climates deteriorate rapidly. Similar paint films applied on structures located in deserts or reasonably dry atmospheres have a longer life. It must be concluded therefore that seaboard exposures are more severe because of the unsatisfactory atmospheric conditions when the paint is applied rather than because of the violence of the attack of agents on the paint film after it has been applied.

The reconditioning of surfaces for field painting therefore should include two distinct operations: the first, a method of removing damaged paint film and rust from the steel surfaces; and the second, a treatment of the surfaces that will remove all moisture from them. The priming coat necessarily must be applied promptly after the second phase of reconditioning has been accomplished.

Rust and damaged paint film are removed commonly by several methods: hand scrapers, sandblasting, power-driven wire brushes, power-driven chipping hammers, and oxy-acetylene flame. Each of these

Photos Courtesy Air Reduction Sales Co.

MAINTENANCE CLEANING AND PAINTING UNDER WAY ON GOLDEN GATE BRIDGE, SAN FRANCISCO
Left, Typical Torch Operations; Right, Scaffolding Under Roadway for Maintenance Work

methods is adaptable to a specific type of surface or structure. Hand scraping is limited to small members such as lattice bars, to surfaces but lightly corroded, and generally as an auxiliary to some other methods. Where the sand can be recovered and where newly painted members can be removed from the sandblasting operations, the sandblast is an efficient tool. Where previous coats of paint are thin and corrosion is light, the power-driven wire brush is especially useful. The use of the oxy-acetylene flame for cleaning is best suited to surfaces where the paint coat is light and the scale is heavy. For surfaces where both the paint and scale are heavy the power-driven chipping hammer has given a good account of itself.

For the accomplishment of the second phase of surface reconditioning—the removal of moisture from the surface of the steel—the oxy-acetylene dehydrating and descaling flame is the most efficient device available. Except in extremely dry climates, this treatment of surfaces gives better results than those obtained from any method of cleaning. It should be considered not as an alternative method of cleaning, but a distinct operation in the preparation of the surface. The flame treatment should be followed immediately by hand wire-brushing, and the priming coat should be applied while the metal is slightly warmer than the surrounding atmosphere. Under such a condition condensation cannot take place on the steel and the paint will have excellent adherence. Where linseed oil primers are used, the application of the priming coat to warm metal will result in a hard film and drying time will be accelerated. This method will permit the use of a heavy primer, which is much to be desired.

EXPERIENCE WITH GOLDEN GATE BRIDGE

These suggestions are a direct result of the writer's experience in the maintenance of the Golden Gate Bridge at San Francisco. Some parts of this structure were painted in 1936, but all of the painting was not completed until December 1937, under the construction contracts. Maintenance painting was begun by the Toll Bridge District forces on January 2, 1938. At that time the surfaces at the bases of the towers and those of the stiffening trusses and floor were covered generously with rust nodules under loosened mill scale. This type of paint failure had been prevalent during the construction period and the contractors had done considerable spotting and cleaning of the steel both before erection and after. Most of the steel for the bridge had been fabricated in the east and, after the application of a priming coat, shipped by water to San Francisco.

In the eastern shops special care was taken in cleaning and painting but no attempts were made to remove tightly adhering mill scale. Sandblasting had been considered by the Board of Engineers of the bridge, but on account of lack of funds to cover the extra cost it was not done. Before erection all the surfaces were carefully cleaned in the presence of an inspector and reprimed. After erection, and before application of the field coats, the primer was again renewed where damaged. Thus the field coats were applied over a prime coat in good condition and there was every reason to believe that an excellent paint job had been obtained.

In spite of all these precautions, failures caused by corrosion beneath the mill scale began soon after the completion of the bridge. These failures are increasing rapidly in area as the exposure continues. This is reflected in the higher cost of cleaning this year than when maintenance was started. Only those areas that show mill-scale blisters are treated. In 1938 this amounted to about 40% of the total surface but at the present time it is approaching totality with respect to the surfaces that have not been subsequently treated to maintenance painting.

After experimenting with various tools for removing the rust and scale, the pneumatic chipping hammers were adopted. Two types of chisels are used with these hammers, one a square-edged flat chisel with a $2^1/_4$-in. face, and the other a cup tool for rivet-head cleaning. Chisels are faced with hard surfacing material to give longer wear and reduce the amount of sharpening necessary. After the rust and scale have been removed with the chisels, the entire surface is swept with the oxy-acetylene flame. This operation removes from the steel the remainder of the mill scale together with the moisture. A quick wire brushing removes the charred paint and the application of the priming coat follows closely. It has been found that primary paint consisting of 28-lb red lead pigment in raw linseed oil vehicle dries quickly and hard on the warm surfaces. In general, the second coat is the same material as the primer with added lamp black. The third coat of paint is a semi-synthetic type consisting of long-oil resin with a small percentage of boiled linseed oil in the vehicle. All paint is applied by hand brushes. On vertical surfaces the finishing stroke is vertical to prevent the retention of moisture in the brush marks.

WIRE BRUSHING (RIGHT) FOLLOWING TORCH TREATMENT (LEFT)

EXPERIMENTAL PAINT TESTS

Besides using red-lead primers, large-scale experimental panels and sections of the structure are coated with other types of primers and combinations of paints. On the bottom flanges of the floor beams at lateral plates, where moisture is retained in foggy weather, two coats of coal-tar base paint are applied. Other sections have been coated with glytol and bakelite-type synthetic paints. Paints pigmented with copper, rubber, and iron oxide are also on trial. All of these tests are made upon surfaces treated in the same manner. From the test program it is hoped to determine the best type of paint to be used in the future.

Not the least part of the painting program is the selection of the proper scaffolding for the various portions of the structure. The scaffolding is designed so that all surfaces are readily accessible and so that the men will be able to work freely and safely. This demands more elaborate scaffolding than is generally used but results in a large saving in the cost of painting and better supervision of the work.

Although the first maintenance work had been exposed more than two years, none of it shows more than a few small rust areas. This is to be compared with the condition of the structure immediately after the first painting, when an average of 40% of the areas that had been exposed for less than a year showed evidence of attack by rust. This indicates that the additional care in the preparation of the surfaces has been worth while.

Kansas City's Municipal Auditorium

Its Design and Construction Problems Solved by Unusual Methods

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RECENTLY Kansas City, Mo., has built a municipal auditorium that is large enough to permit 25,000 people to attend four simultaneous functions; extensive enough to handle automobile shows, athletic contests, concerts, national conventions, or housing exhibits; inclusive enough to provide a huge air-conditioned auditorium, a beautiful theater, and an adequate function room for receptions and balls. The roof span over the arena provided the main structural design problem; and the large volumes of water in the foundations and the erection of the heavy roof trusses over the auditorium constituted the principal construction problems. This article has been prepared from a paper presented before the Construction Division at the Society's Spring Meeting in Kansas City.

DESIGN of the Kansas City Municipal Auditorium is the result of the combined efforts of two firms of architects, a structural engineering firm and a mechanical engineering firm, all working in conjunction with, and under the supervision of the Director of Public Works of the City of Kansas City, Mo. It was the wish of the city that the following features be incorporated: a large auditorium seating 12,000 to 15,000 people; an exhibition hall for such spectacles as automobile shows and better homes exhibits; a fully equipped theater with a seating capacity of 3,000; a function room for balls and receptions; and finally, a good supply of committee rooms. The auditorium, theater, function room, and exhibition hall were to be air conditioned.

First, of course, the architects and engineers prepared sketches and drawings showing several schemes for adapting the structure to the sloping terrain upon which it was to stand. Finally, after securing approval of these preliminary plans by the city and interested civic groups, they set to work on the detail design and drawings.

In the execution of the plans it was necessary for the designers to give constant consideration to the following features: (1) a thoroughly fireproof structure; (2) a system of entrance and exit ramps, so that the public could quickly and conveniently reach the several portions of the building from the main entrance, but more particularly so that the entire building could be rapidly emptied, especially in the case of an emergency; (3) a method of economical heating; (4) an air-conditioning and ventilating system; (5) a scheme of illumination which would be so flexible that the requirements of any type of show, exhibition, or entertainment could be met; and (6) building of best possible public address system.

The final plan resolved itself into two separate units under one roof but with the general exterior appearance of one building. The first and larger unit is the auditorium and exhibition hall, and the second and smaller unit, the theater and function room. Each unit has a goodly share of committee rooms. An area of 301 by 291 ft was set aside for the auditorium, and an area of 283 by 116 ft for the theater and function room.

Since no columns were to be permitted in the auditorium, the structural engineer was confronted with an unusual roof problem, further complicated by the demand of the city and by architectural requirements that the top 30 ft of the exterior walls be set back. After careful study a system of four sets of twin columns was devised as an interior support for the roof, with the four exterior walls supporting its outer edges.

These four sets of twin columns were located as shown in Fig. 1. From an architectural standpoint these locations were satisfactory; they did not interfere with the general ceiling design and could be concealed by the metal lath and plaster furring that forms the interior walls at each end of the auditorium.

By working in close harmony with the architects and mechanical engineers the structural engineer obtained the weights to be supported by the roof, such as the ornamental plaster cornice, the suspended ceiling, the ventilating ducts, the ventilating fans, the spotlight booths, and the electrical reactor room. With this information, and with the wind and snow loads prescribed by the Kansas City Building Code, he was in a position to proceed with his roof design.

The four sets of twin columns were utilized to support four main carrying trusses. The span of the two trusses running east and west was 226 ft (*A* trusses in Fig. 1) and that of the two trusses running north and south was 187 ft (*G* trusses in Fig. 1). Since it was the wish of the architects to carry the 30-ft east-and-west exterior offset walls on the *G* trusses, the engineer decided to support the roof over the arena floor on the *A* trusses.

This put a big responsibility on these long-span trusses, and in order to save weight silicon steel was employed. After the stresses in the several members of the trusses had been determined, it was decided to use built-up sections for the chords, and riveted connections at all panel points. The maximum chord stress was 3,460 *K*. The largest chord member was made up of four angles 8 by 8 by $1^1/_8$ in., two web plates 20 by 1 in., two cover plates 24 by $^5/_8$ in., and four cover plates 24 by $^3/_4$ in., making a total cross-sectional area of 209 sq in. These trusses were investigated for secondary stresses, and the proportioning of the members was revised accordingly.

Traveler, with Four Derricks Mounted on Top, Erecting Bottom Chord of South *A* Truss Over Auditorium

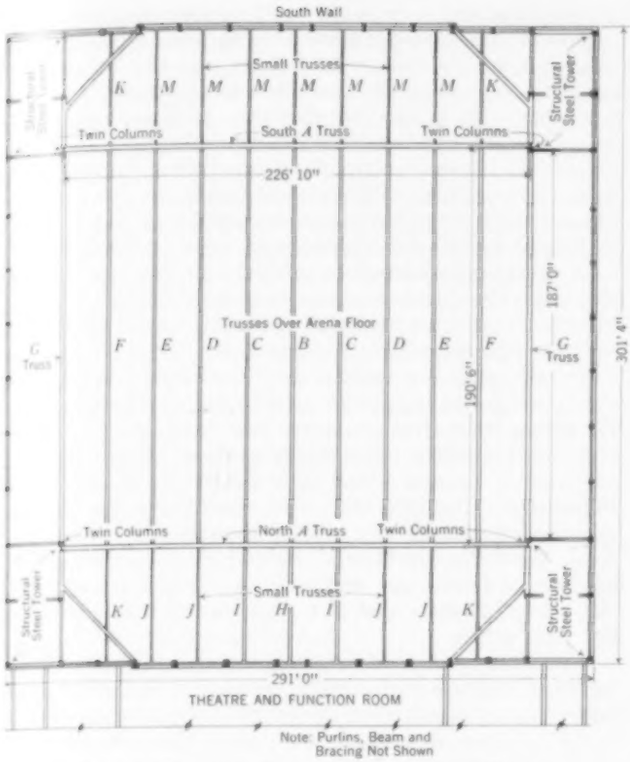


FIG. 1. FRAMING PLAN OF AUDITORIUM ROOF

The outline of one of the *A* trusses is shown in Fig. 2. The depth at the center is 30 ft. The trusses were detailed and fabricated with a camber of 3 in. and each weighs 240 tons. The *G* trusses being shorter in span are much simpler and lighter although they carry a masonry wall 12½ in. thick and 30 ft high. Their depth is 27 ft 3 in. and their weight 90 tons. When the wall was completed, it was found that nearly all of the 2½-in. camber had been used up. Here were trusses which did not have to wait for a big snow to get their full load!

In the twin column arrangement, one of the pair supported an end of an *A* truss and the other an end of a *G* truss. The trusses were pin connected to the columns, 9-in. diameter pins being required for the *A* trusses and 7-in. diameter pins for the *G* trusses. The top 30 ft of each of these columns was unsupported, so as to allow the expansion and contraction of the trusses to be taken in bending in the columns. From the point of the top support downward, each pair of columns is rigidly supported laterally by being tied to the structural steel tower shown in Fig. 1. These towers are located at the four corners of the auditorium and extend from the basement to the roof.

The nine 190-ft 6-in. trusses over the arena floor did not present an unusual problem except in the arrangement of the panels and bracing to provide space for the air-conditioning and ventilating ducts, catwalks, and machinery supports. They are rigidly connected to the two *A* trusses. The connections for the small trusses which extend from the *A* trusses to the north and south end walls, however, did present a problem involving expansion and contraction. Any change in length of the nine trusses over the arena floor would certainly cause a lateral movement in the *A* trusses. Since the wall end of these trusses was supported on stiff steel columns, it was necessary to provide the expansion arrangement at their connection to the *A* trusses. Figure 3 illustrates the detail of the expansion connection.

From the *G* trusses to the east and west walls, the roof over the 31-ft span was supported on wide-flange beams, rigidly connected to the *G* trusses at one end and supported by steel columns extending upward from the concrete seat ramps at the other end.

For the roof, the architects selected a commercial steel deck and specified that it be electrically welded to the steel purlins. This was covered with 2 in. of cork insulation and a twenty-year, four-ply, built-up roof. The roof structure and the four structural steel towers at the corners constitute all the structural steel in the auditorium unit of the building. The remainder was of reinforced concrete.

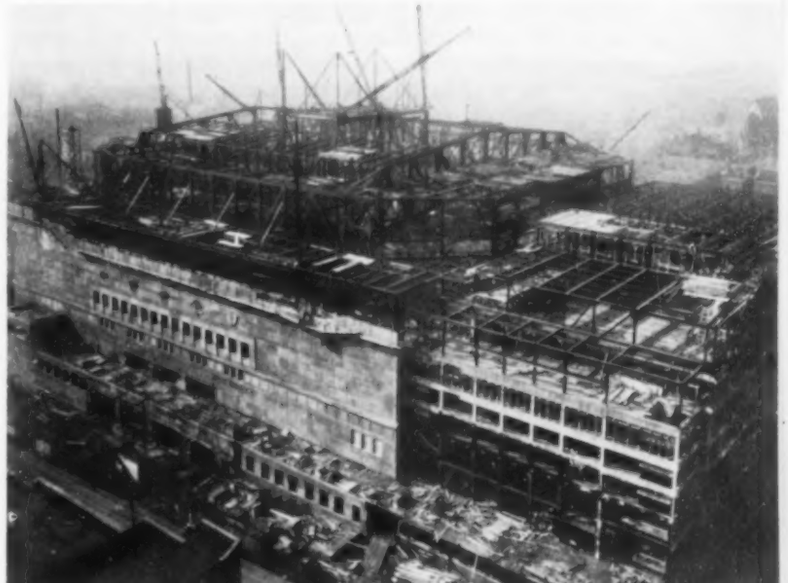
The next unusual problem in the auditorium portion of the building was to design a floor structure for the arena which would provide a span of 86 ft in the exhibition hall below. After studying different types of construction, the engineer decided on long (86-ft) span concrete beams with long straight haunches at each end, to extend over a 22-ft bay at each end, forming three spans, as shown in Fig. 2. The cross section of these long-span beams is 18 by 48 in. at the center, and 18 by 72 in. at the haunches. It is 18 by 72 in. for anchor spans. These long beams are spaced 6 ft 6 in. center to center, and a 4½-in. slab between them forms the floor.

Every third long-span beam is supported by concrete columns; the two intermediate ones being framed into 30 by 72-in. concrete girders. In order to further reduce the moment at the center of the long-span beams, the 30 by 72-in. girders and the supporting columns were proportioned to take their respective share in the moment distribution. The long-span beam construction is flanked at each end by typical concrete joist construction with an open construction joint at the outer face of the two outside long-span beams.

The seat ramps and supporting girders and columns were also constructed of reinforced concrete. Although the girders were relatively large, they did not present any difficult problems. It will be noted in Fig. 2 that the line of balcony seats extends over the arena floor boxes—supported by extending each of the main seat ramp girders beyond its lower supporting column as a cantilever.

The remainder of the floors throughout the building were of reinforced concrete joist construction. The joists were from 8 to 12 in. wide, 21½ in. deep, and spaced 4 ft 6 in. from center to center. The slab between was generally 3½ in. thick. The girders, where possible, were made the same depth as the joist construction so as to give the maximum net ceiling height.

Core borings showed that, at an average depth of 40 ft below the basement floor, there existed a 10-ft ledge of hard gray limestone. Immediately below this lime-



SETTING THE NINE INTERMEDIATE TRUSSES OVER THE ARENA FLOOR; THE BUILDING AT RIGHT IS THE THEATER SECTION

NIGHT VIEW OF KANSAS CITY MUNICIPAL AUDITORIUM

stone was a stratum of hard blue shale 11 ft thick, and underlying this shale was a second ledge of hard gray limestone 10 ft thick. Because of this foundation condition, the building was designed to rest on concrete piers extending down to the top of the upper limestone ledge. To make sure of the thickness of the supporting stratum at each pier, a 2-in. diameter test hole was bored entirely through it.

Round piers were designed for each column concentration and the lower end was belled out so that the rock pressure would be uniform. The pier shafts varied from 3 ft 6 in. in diameter to 8 ft. 4 in. A stress of 550 lb per sq in. in compression on concrete was used in designing the pier shafts, except that 3 ft 6 in. was decided to be the smallest space a man could profitably work in. The diameter of the bells was proportioned for a rock pressure of 30 tons per sq ft, or approximately 417 lb per sq in. The diameter of the largest bell was 10 ft 6 in. A deviation from the vertical of 1 ft in 60 ft was allowed in the excavation of the pier holes, and this ratio was one of the routine measurements taken in making the record of the holes.

A general contract for the auditorium unit and for the structural frame and exterior walls of the theater unit was awarded to a combination of three construction companies. The general contract included heating, plumbing, ventilating, air conditioning, and electrical work. Construction was started in June 1934, and the auditorium unit was completed in the autumn of 1935. The contracts for the finishing of the theater unit were let in the fall of 1935 and the entire municipal auditorium structure was completed in the spring of 1936.

WATER DIFFICULTIES IN FOUNDATIONS

Most of the 327 piers required both rock and shale excavation. Consequently the contractors set up a central compressor plant and put in a series of air mains to cover the area of the building. With air available, air pumps were used to lift the water out of the holes. Windlasses, with heavy manilla rope and steel buckets, were employed in getting the material to the surface.

Because of the presence of water, the foundation work continued 24 hours a day. In a number of cases the flow into a single hole was as much as 12 gal per min. Water showering in 20 ft or more above the bottom of the hole not only made mucking very unpleasant work but also caused trouble in pouring the concrete. The specifications required that the concrete be deposited through an elephant-trunk tubular steel sectional spout with a hopper at the top—an ideal way to pour a pier in a dry hole, but with a flow of 12 gal per min the water would build up on top of the concrete so fast as to become intolerable. To overcome this the sectional spout was removed and the hole was filled rapidly by dumping in six, eight, or ten truck loads of concrete at once until the concrete level rose to the point of entrance of the water. Open chutes from each concrete truck extended to the hopper at the top of the hole and, when the water in the hole was pumped down to within 2 in. of the bottom of the hole, the pump was removed and the gate on each concrete truck was opened. The concrete was poured into the hole in one to two minutes.

Following the construction of the piers, the four steel towers were erected one in each corner of the auditorium. Simultaneously the concrete work was started. Since this work constituted a large portion of the contract, and had to be completed to the tops of the seat ramps before the structural steel roof could be erected, it was prosecuted vigorously. The contractors built their forms in the conventional way except that a patented removable joist form was used in all pan construction, and an adjustable steel bar joist was used in supporting the joist soffits.

Two concreting towers, one on the east side of the building and one on the west, permitted both sides of the structure to be carried up at the same time. Ready-mixed concrete from a central mixing plant was delivered directly to hoppers at the foot of the concrete towers. After being raised to the floor level, the concrete was distributed by hand buggies.

The form work for the long concrete spans over the exhibition hall required careful planning and construction. The deep beams not only constituted a heavy load to be carried on the 26-ft supporting shores, but their unusual depth necessitated forms typical of concrete wall construction with studs, wales, and wall ties. The contractor used $^3/_4$-in. plywood for these forms and for all exposed concrete in the arena of the auditorium,

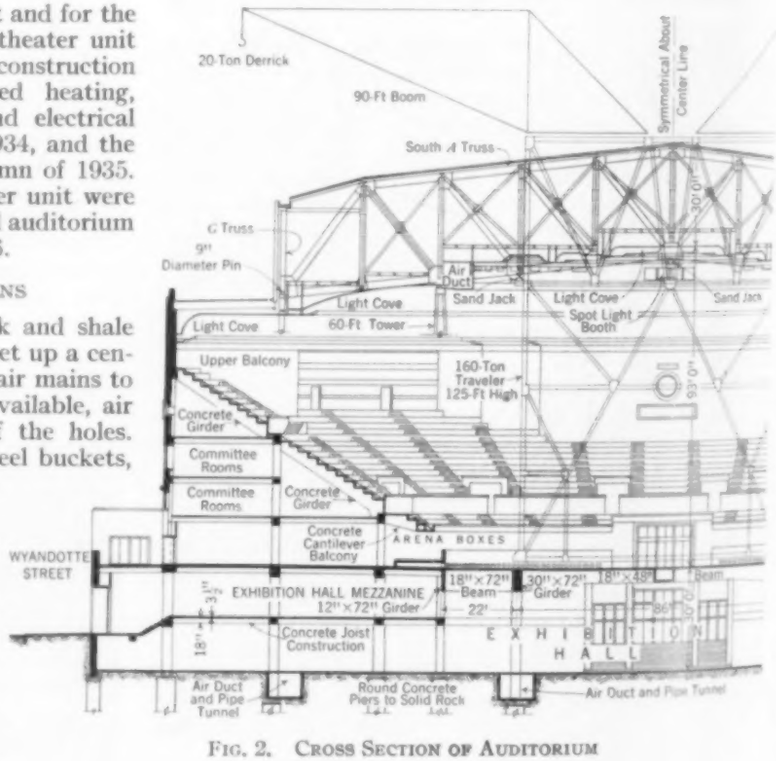


FIG. 2. CROSS SECTION OF AUDITORIUM

including the overhanging balcony, balcony walls, division walls, faces of seat ramps, and steps.

Before the last section of the seat ramps had been poured, the structural steel contractor prepared for the erection of the roof trusses. He built a traveling steel tower of structural steel on the arena floor, 125 ft high, 86 ft long, and 65 ft wide. This 160-ton tower had a 20-ton stiff-leg derrick with a 90-ft boom mounted at each top corner with a 100-hp hoisting engine mounted near the base under each derrick. The tower itself was moved over the arena floor on heavy wooden rollers.

Roof steel was delivered by truck at the south end of the auditorium and unloaded by the derricks on top of the traveler. The first steel erected was the bottom chord of the south *A* truss. This was delivered in a number of pieces and was placed on a set of five sand-jacks—three located on projections from the traveler and two located on specially erected steel towers, all as shown in Fig. 2. The sand jacks consisted of rigid, open-topped steel boxes 12 in. wide, 12 in. deep, and 2 ft 8 in. long. A 12-in. wide-flange beam, with stiffeners between the flanges, placed on top of the sand in the box, served as a plunger to support the load to come upon the jack. A number of plugged holes in the sides of the boxes let out the sand as desired.

The sand in the jacks was so regulated that the middle of the bottom chord of the truss rested in a position about 7 in. higher than its final position. The end pins were then placed, and the end posts, top chord, and laterals erected. As the members of the truss were connected from the support toward the middle, sand was taken from the jacks. When the final connections were made and all riveting was completed, more sand was released and the trusses were permitted to swing free.

After filling in the area of roof steel between the south *A* truss and the south wall, the steel contractor proceeded with the erection of the *G* trusses. These trusses were assembled in three sections on the arena floor level and were hoisted into position by means of two derricks. Each section weighed about 30 tons. In order to support the trusses while the connections were being made, two temporary steel towers were erected at approximately the third points of the span. Following the erection of the *G* trusses, the traveler was used to erect the north *A* truss and all steel north of it. Then it was moved back to the center of the arena floor, and the nine trusses over that floor were erected. These were assembled on the floor and hoisted into place. Finally, the bracing, purlins, and the thousands of light sections forming the air ducts, light coves, and catwalks were erected. The traveler proved successful in placing over 1,000 tons of roof steel without any mishaps worth mentioning. While the steel was being erected the contractors proceeded with the exterior walls, the interior floors and fills, the partitions, and the plastering.

The next unusual feature was the lathing and plastering of the arena ceiling. As seen in Fig. 2, the ceiling extends from the top of the seat ramps on each side to a high point in the middle 93 ft above the floor. This work required a substantial hanging scaffold to cover the entire area of the floor and seat ramps. Because of the breaks in the ceiling, different portions of the scaffold had to be constructed at different elevations.

The air-conditioning system, located in the basement, consists of four 300-ton, four-cylinder, single-acting compressors connected to shell and tube type water coolers and condensers each direct-connected to a 400-hp engine-type 225-rpm synchronous motor. Two air washers are located in the basement and one each in the four corners of the auditorium at the level of the top of the seat ramps.

Smoke is exhausted by a system of ducts and a 50,000-cu ft per min fan, located above the ceiling. Heat from lighting is exhausted by a system of supply and exhaust ducts and fans also located above the ceiling. All air in the arena portion of the auditorium can be completely changed every ten minutes. Including the theater structure, a total of 56 supply and exhaust fans handle 1,860,000 cu ft per min.

Electric power is purchased at 13,200 v and is stepped down to 110 v for distribution by a four-pole copper buss of 2,000 to 4,000-amp capacity, which encircles the building. To provide an intensity of 70 ft-c at the arena floor and to flood the upper cove with colored lights, a total of 368,000 w is needed.

The latest equipment obtainable for the public address system was purchased and assembled in the radio equipment room. Microphones may be plugged in at several locations, and after amplification the sound is projected from a battery of loud speakers suspended from the ceiling in the south central part of the arena. Loud speakers are also located in corridors and in several committee rooms.

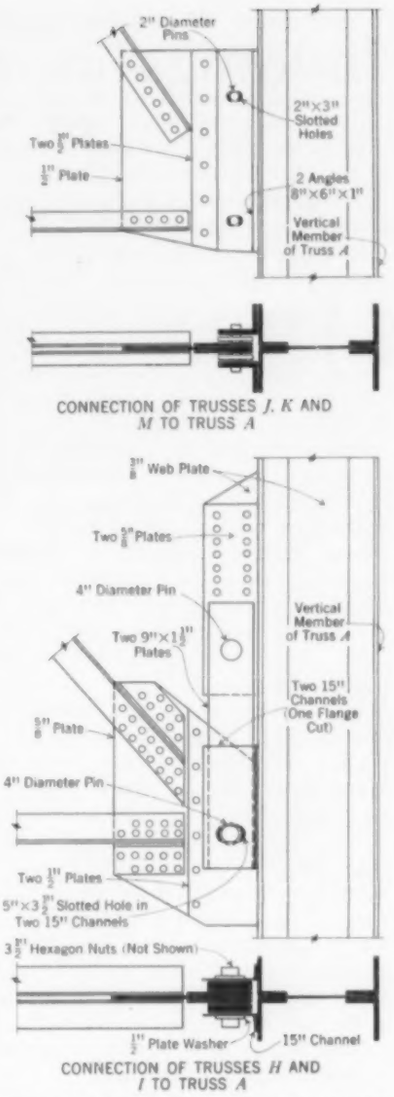

2" Diameter Pins
Two ⅜" Plates
½" Plate
2"×3" Slotted Holes
2 Angles 8"×6"×1"
Vertical Member of Truss A
CONNECTION OF TRUSSES J, K AND M TO TRUSS A
⅜" Web Plate
Two ⅝" Plates
4" Diameter Pin
Two 9"×1½" Plates
Vertical Member of Truss A
Two 15" Channels (One Flange Cut)
⅝" Plate
4" Diameter Pin
Two ½" Plates
5"×3½" Slotted Hole in Two 15" Channels
3½" Hexagon Nuts (Not Shown)
½" Plate Washer
15" Channel
CONNECTION OF TRUSSES H AND I TO TRUSS A

FIG. 3. PIN-CONNECTED EXPANSION SUPPORT FOR SHORT TRUSSES

This complete auditorium and theater structure has a combined cubage of 16,000,000 cu ft and covers a ground area of 426 by 352 ft. The auditorium will seat 14,000 people, the theater 3,000, the function room 900, one committee room 500, two committee rooms 225 each, and 27 committee rooms from 25 to 250 people each. The exhibition hall may be in use by 5,000 people or more without in any way affecting the other portions of the building. In all some 25,000 people could be attending four different functions at the same time. A great variety of shows, functions, and entertainments have been held in the building.

The building was constructed with the aid of a PWA 30% grant. Kansas City furnished its share of the money from a bond fund. The total cost, including land and all equipment, was about $6,500,000. The firm of Alonzo H. Gentry, Voskamp and Neville, and the firm of Hoit, Price and Barnes served as architects. Irwin Pfuhl was structural engineer, and W. L. Cassell mechanical engineer. All are Kansas City, Mo., people.

Investigation of the Discharge and Coefficients of Small Circular Orifices

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SMALL brass-plate orifices whose discharge coefficients check each other within a tenth of 1% have been constructed at the Johns Hopkins University, by means of a special yet simple manufacturing technique. In the accompanying article Messrs. Medaugh and Johnson explain the method of construction, and describe in considerable detail their calibration tests. A table of coefficients for a wide range of heads, for orifices varying in diameter from 0.25 to 4.00 in., is presented, and the authors conclude that other experimenters using the same method of making the plates should obtain coefficients within one-third of 1% of those given here.

USUALLY, when carrying out precise hydraulic experiments in the field, and occasionally also when conducting such work in the laboratory, it is not practical to measure the water volumetrically or by weighing, and resort must be had to some auxiliary measuring device such as a venturi meter or a weir. These auxiliary measuring devices, however, have the common weakness that it has not been practical, so far, to reproduce them with sufficient accuracy to enable the experimenter to use, with the reproductions, the discharge coefficients of the standard measuring devices and be sure of results as precise as he often would like to have. The device that would seem most promising as regards freedom from this weakness is the circular orifice in the vertical side of a large tank. It could be used to advantage in many cases in practice, if a method of manufacture were developed which would consistently give a perfectly square inner edge to the opening and if the discharge coefficients for such an opening were known with sufficient accuracy for different heads and hole diameters. It is to the solution of these two problems that this paper is devoted. At the same time the knowledge gained may be of advantage in making orifice plates for use in pipe lines.

On account of the decrease in the accuracy obtainable when the head drops below 0.8 ft, it was decided that no effort would be made to obtain coefficients for heads smaller than this. Also, on account of the limited funds available, it was decided that it would not be practical to take measurements on orifices larger than 2 in. in diameter.

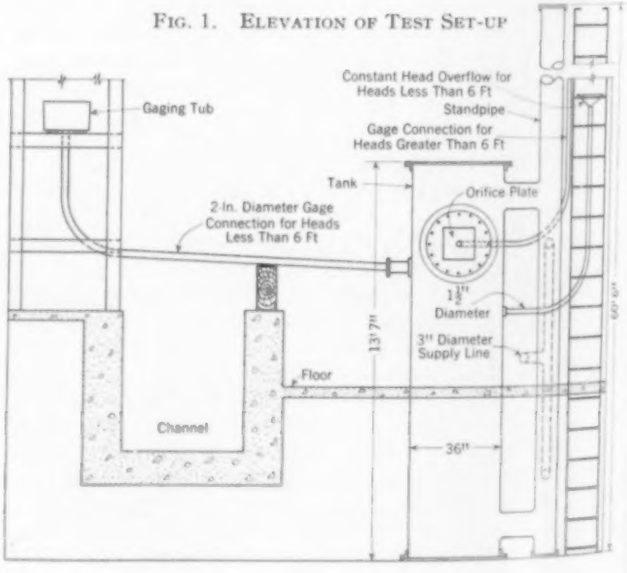
The orifice plates were made of sheet brass $^1/_4$ in. thick, and were more than seven diameters square. They were mounted by means of countersunk screws (placed at the corners) on steel plates $^1/_2$ in. thick, both of whose surfaces had been ground to parallel planes. Five sizes of orifice openings were used: $^1/_4$ in., $^1/_2$ in., $^3/_4$ in., 1 in., and 2 in. The orifice openings were drilled and reamed, care being taken to make the openings perpendicular to the faces. Then the edges of the openings were oiled and fillings of dental amalgam were inserted. Finally, the brass plates were carefully ground to surfaces parallel with those of the steel plates and the plugs were gently tapped out of the holes. (To save amalgam on the larger openings, brass plugs were inserted in the holes and the spaces between the plugs and the orifice edges were filled with amalgam.) Examination of the edges with a powerful magnifying glass showed that this method gave extremely good results.

The plates were mounted, one at a time, with the brass side facing the water, on the side of a vertical tank 3 ft in diameter and $13^1/_2$ ft high (see Fig. 1) and water was admitted to the tank equally at the top and bottom through 10-in. pipes. This made the velocity of approach negligible and introduced the water with a minimum of disturbance, eliminating the need for baffles. Water was delivered to the tank by means of a 3-in. centrifugal pump, and the discharge from the orifice was allowed to flow back to the intake well, thus keeping the intake water-level constant.

The pressures on the orifices were kept constant within $^1/_8$ in. for heads between 6 ft and 50 ft, by means of overflow plugs placed every foot in a 10-in. vertical standpipe attached to the tank. For heads of 6 ft and less, the pressures were kept constant within 0.002 ft by means of an overflow made of a large metal lamp reflector, inverted and attached to a large-diameter hose. The overflow was supported on a ladder to one side of the standpipe and, for different heads, was moved from rung to rung.

Heads between 6 ft and 50 ft were measured by means of a scale attached to the standpipe and a rubber garden hose attached to the back of the tank at a point directly opposite to the orifice. A large-diameter glass tube on the end of the hose enabled the water level to be read. For water depths of 6 ft and under, the heads were measured by one or another of three hook gages, mounted one above the other on a heavy, built-up, wooden column. These gages dipped into a galvanized tub from the bottom of which a 2-in. hose led to the tank. The tub could be supported at different levels on a wooden frame which

FIG. 1. ELEVATION OF TEST SET-UP



was independent of the hook gage support. For pressures above 50 ft, the heads were measured by means of a mercury gage. When using the mercury gage, head readings were taken every half minute. All other head readings were taken at the end of each minute throughout the run.

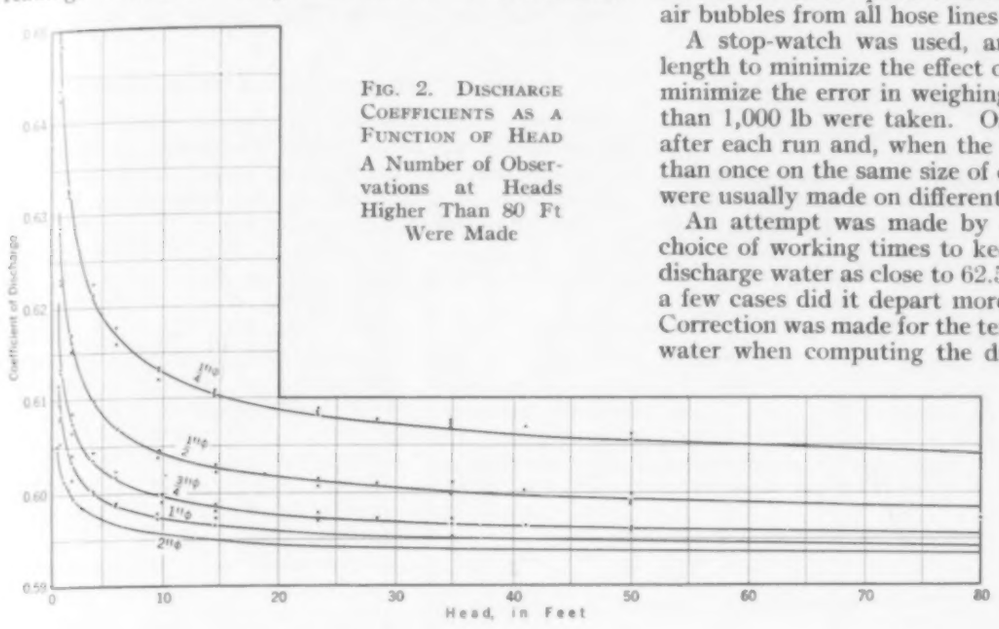


FIG. 2. DISCHARGE COEFFICIENTS AS A FUNCTION OF HEAD
A Number of Observations at Heads Higher Than 80 Ft Were Made

Most of the discharges were determined by conducting the water through a spout to two tubs on platform scales and weighing the tubs filled and empty. However, the discharge from the 1-in. orifice under the highest head was determined by discharging into a concrete channel, waterproofed and carefully calibrated by filling it with weighed water. Discharge from the 2-in. orifice was determined by placing it in a baffle across a 4 by 4.5-ft concrete channel and allowing the previously calibrated 1-in. orifice to discharge into the channel under a carefully measured head. The channel hook gages were mounted on a heavy steel frame, firmly fastened to the concrete.

Before beginning the experiment, all equipment was carefully calibrated and all necessary zero readings were taken. Zero readings were also taken before each run, and, in a few cases, at the end of the run as well. The scale was calibrated by comparing it with a steel tape which had been calibrated at the U.S. Bureau of Standards. The orifice diameters were measured by the U.S. Bureau of Standards along two diameters at right angles to each other, and an average was taken. The platform scales were carefully tested by the Baltimore City Bureau of Weights and Measures and were also tested from time to time by the writers. (As determined by test, the evaporation losses were negligible.)

The scale and hook-gage zero readings were obtained by setting up a high-powered wye level by trial until the horizontal hair was just level with the bottom of the orifice and then taking a reading on the scale and on the hook gage when the hook was level with the horizontal hair. It was estimated that the hook-gage zero could be determined within a quarter of a thousandth of a foot. The level was carefully adjusted before any readings were taken, and allowance was made for the radius of the orifice.

Care was taken, before each run, (1) to see that the inner face of the orifice plate was perfectly clean and free from grease, rust particles, or slime; (2) to see that the face of the orifice plate was vertical; and (3) to remove air bubbles from all hose lines by thorough flushing.

A stop-watch was used, and runs were an hour in length to minimize the effect of error in the timing. To minimize the error in weighing, no water weights of less than 1,000 lb were taken. Orifice plates were removed after each run and, when the same head was used more than once on the same size of opening, the different runs were usually made on different days.

An attempt was made by means of ventilation and choice of working times to keep the temperature of the discharge water as close to 62.5 F as possible, and in only a few cases did it depart more than 3° from this point. Correction was made for the temperature of the discharge water when computing the discharge in cubic feet per second. Correction was also made for the temperature of the water gage column; and, to do this, readings were taken at the top and bottom of the column at the beginning and end of each run, and a draft was created up the shaft to keep the column temperature as nearly uniform as possible. The pressures were expressed in terms of feet of head of distilled water at 60 F.

The local acceleration of gravity was used in computations and allowance was made for the buoying effect of the atmosphere on the water while it was being weighed. According to the International Critical Tables, the amount of air in solution in the water should have no appreciable effect on the result. Also, the average city water here is sufficiently pure so that no correction is necessary to take care of salts in solution. Where necessary, corrections were made for capillarity by using the data of R. G. Folsom published in *Instruments*, February 1936, pages 36–37.

RESULTS OF THE TEST

The test results are presented graphically in Figs. 2 and 3 and summarized in convenient form in Table I. The plotted points in Fig. 2 are actual observations, while the coefficients listed in the table have been interpolated for uniform increments of head and adjusted to correspond to the exact nominal diameters of the orifices. Also, in the table, computed coefficients for a 4-in. orifice have been included. Attention should be called to the fact that tests made with an orifice plate constructed in the usual manner—that is, without grinding the surface—showed coefficients about 4% higher than those obtained with the ground plates, but the coefficients obtained by using two ground plates with the same size of opening checked each other within less than 0.1%.

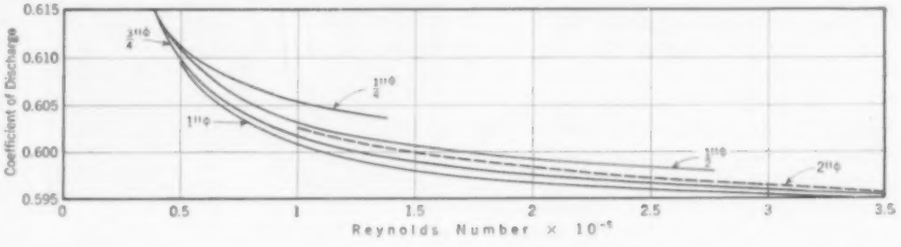


FIG. 3. DISCHARGE COEFFICIENTS AS A FUNCTION OF REYNOLDS NUMBER

The curves in Fig. 2, for orifices smaller than 2 in. in diameter, were obtained from the following empirical formula, which fits all the data exceedingly well except that for the 2-in. orifice:

$$C = 0.5880 + \frac{0.0045}{d^{2/3}} + \frac{0.0075 + 0.0582\ (10^{-0.8804})}{\sqrt{H}}$$

where H is expressed in feet and d in inches. The formula was derived for the purpose of extending the curves beyond the range of the data and determining their probable point of intersection, rather than for use in computing discharge coefficients.

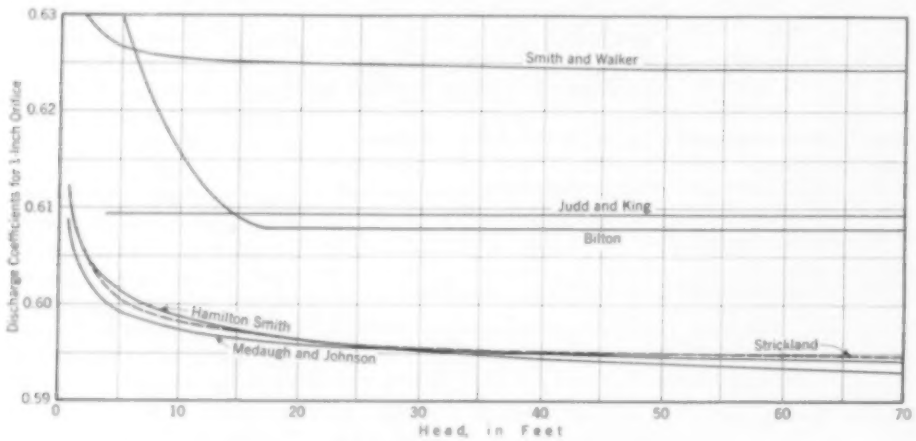


FIG. 4. COMPARISON OF ORIFICE COEFFICIENT DETERMINATIONS BY VARIOUS EXPERIMENTERS
Curves Here Shown Are for Orifice 1 In. in Diameter

In Fig. 3, where coefficients of discharge are plotted against the Reynolds number, it will be noted that all the points except those for the 1/4-in. orifice fall within 1/4 of 1% of a single line. There are at least two reasons why all the points should not fall exactly on a single line: (1) To have exact similarity between a large orifice and a small orifice half the diameter, not only should the same Reynolds number exist in the two cases, but the atmosphere into which the large orifice discharges should have twice the pressure of the atmosphere into which the small orifice discharges. (2) If a small orifice and an orifice double the size are to have the same Reynolds number with a fluid of the same viscosity flowing through both, the head on the large orifice must be a quarter of the head on the small orifice. With the small head, the percentage of velocity difference between the top and bottom of the orifice may be appreciably different for the large orifice from what it is for the small orifice, and true similarity will not exist.

SOME CONCLUSIONS DRAWN

The writers have reached the following conclusions with regard to the experiment:

1. The coefficient of discharge for perfect contraction is about 0.588.

2. It should be possible for any other experimenters using the same method of making the orifice plates and sufficient care in measuring the heads to obtain coefficients within 1/3 of 1% of those here given, for heads between 2.0 and 50.0 ft. Preferably orifices equal to or greater than 1 in. in diameter should be used, so that any error in measurement will not be too great a percentage of the total diameter.

3. Although no measurements were taken on 4-in. orifices, cross plotting indicates that, for heads in excess of 4 ft, the values of the discharge coefficients are about a tenth of 1% less than those for the 2-in. orifice. For this reason coefficients for the 4-in. orifice are included in Table I.

OTHER INVESTIGATORS HAVE MADE STUDIES

Previous experimenters on circular vertical orifices whose results are most frequently quoted by hydraulic engineers may be listed (along with references to the publications in which the results appear) as follows: (1) Hamilton Smith, *Hydraulics*, 1886; (2) Horace Judd and Roy S. King, "Some Experiments on the Frictionless Orifice," *Engineering News*, September 27, 1906, page 326; (3) H. J. Bilton, *The Engineer*, June 19, 1908, page 648; (4) T. P. Strickland, *Transactions*, Canadian Society of Civil Engineers, Vol. 23, pages 185–206; (5) Dempster Smith and William J. Walker, "Orifice Flow," *Proceedings*, Institution of Mechanical Engineers, January 1923, page 23. The coefficients obtained by different experimenters are shown graphically for a 1-in. orifice in Fig. 4.

The discharge coefficients of Smith and Walker, which are probably those in most common use at the present time, are considerably greater than those obtained by the writers; the 3/4-in. orifice is greater, in most cases, by 6%; the 1-in. by 5%; and the 2-in. by 2%. In spite of the doubt cast upon the reliability of Hamilton Smith's orifice experiments by recent writers on hydraulics, his discharge coefficient curves for orifices greater than 1/4 in. are practically within 1/3 of 1% of those obtained by the writers. The results of T. P. Strickland are even closer than this. The greater magnitude of the coefficients obtained by more recent investigators was perhaps due to a slight depression in the plate surface near the orifice opening, resulting in some way from the drilling operations. The thicker plates of Hamilton Smith might not have contained such a depression. Thin plates, not properly backed up, might also be bowed slightly by the pressure in the tank.

TABLE I. DISCHARGE COEFFICIENTS FOR VERTICAL CIRCULAR ORIFICES (MEDAUGH AND JOHNSON)

HEAD IN FT	ORIFICE DIAMETER IN INCHES					
	0.25	0.50	0.75	1.00	2.00	4.00
0.8	0.6468	0.6268	0.6156	0.6093	0.6031	0.6010
1.4	0.6352	0.6192	0.6101	0.6052	0.6009	0.5995
2.0	0.6287	0.6153	0.6073	0.6031	0.5998	0.5987
4.0	0.6206	0.6094	0.6032	0.6000	0.5976	0.5968
6.0	0.6167	0.6068	0.6014	0.5986	0.5965	0.5958
8.0	0.6144	0.6052	0.6003	0.5978	0.5959	0.5953
10.0	0.6128	0.6042	0.5995	0.5972	0.5955	0.5949
12.0	0.6116	0.6034	0.5990	0.5968	0.5952	0.5947
14.0	0.6107	0.6028	0.5985	0.5965	0.5950	0.5945
16.0	0.6100	0.6023	0.5982	0.5963	0.5949	0.5944
20.0	0.6090	0.6016	0.5977	0.5959	0.5946	0.5942
25.0	0.6079	0.6009	0.5972	0.5955	0.5942	0.5938
30.0	0.6071	0.6004	0.5969	0.5952	0.5940	0.5946
40.0	0.6061	0.5997	0.5964	0.5949	0.5938	0.5934
50.0	0.6054	0.5992	0.5960	0.5946	0.5936	0.5933
60.0	0.6049	0.5989	0.5958	0.5944	0.5934	0.5931
80.0	0.6041	0.5984	0.5954	0.5942	0.5933	0.5938
100.0	0.6036	0.5980	0.5952	0.5940	0.5931	0.5928
120.0	0.6033	0.5978	0.5950	0.5939	0.5931	0.5920

Note: Temperature of discharge water 62.5 F. Heads are expressed in feet of water at 60 F.

The Port of New York—Bayonne Terminal

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A GREAT port like New York never is completed. Recently a huge four-million-dollar ocean terminal of the quay type has been extended out from the New Jersey shore at Bayonne. Its purpose, design, construction, and operation are here described. Special problems involved dredging and filling of eight million yards, pile driving, and other details of the 9,300-ft bulkhead, and shed construction, including provision for movement of column bases. The original paper, presented before the Waterways Division in January, from which this is an abridgment, has been filed in the Engineering Societies Library.

ONE of the newer major facilities of the Port of New York, built by the city of Bayonne, N.J., but under a long-term lease for private operation, is the Bayonne Terminal. With its causeway, it projects about two miles out from shore into the Upper Bay (Fig. 1).

Primarily this ship-to-rail terminal is intended to provide facilities for the transshipment of exports and imports, as well as auxiliary ship-side storage within its transit sheds, in order to expedite and minimize the handling of goods, thereby effecting real economies. The space devoted to the transshipment of goods comprises a marginal zone about 300 ft wide, adjacent to the bulkhead surrounding the property, leaving an inner or central area for industrial development. The length of quay is about 9,300 ft, sufficient to berth simultaneously 18 ships of the average gross tonnage of a freighter. The industrial development area comprises about 100 acres.

At the outset, the problem of designing the layout of the terminal involved three essential factors:

1. There was available an area of lands under water 700 acres in extent, with only a small fringe of upland not exceeding 40 acres and unusable.

2. The boundaries of the property acquired by the city gave the tract of land under water an irregular trapezoidal shape, with its greater base on the shore about 4,000 ft in length, and its lesser base, approximately 2,200 ft in length, coincident with the U.S. Pierhead Line. The distance between the two bases, or the height of the trapezoid, was approximately 10,000 ft. In other words, at this particular location the pierhead line in New York harbor is nearly two miles from the shore line. The main channel of New York harbor is about 3,000 ft east of the pierhead line.

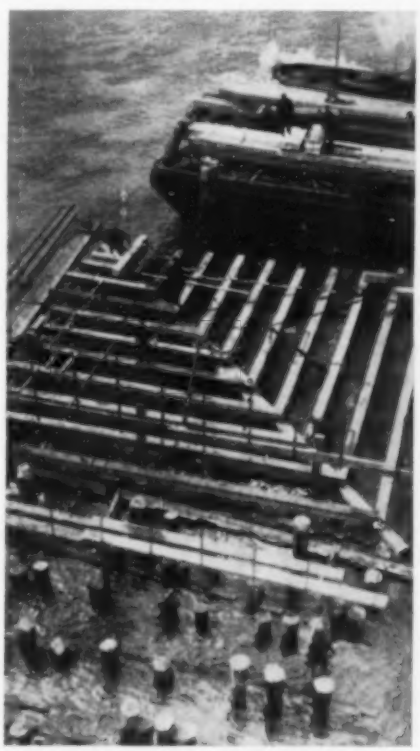
3. The available funds were limited.

The solution required that as much land be reclaimed and as many linear feet of berthing space be provided as the funds would permit, with proper provision for future expansion at least cost. Bearing in mind that adoption of a quay type of dock was fundamental, and considering the three factors just mentioned, it was finally decided that the soundest and most economical development would be to locate the east bulkhead at or very close to the pierhead line and extend the reclamation of the lands under water westward, with channels on each side of the terminal and an entrance channel from the pierhead line to the main ship channel of the harbor. Since, obviously, the funds available would permit reclaiming only part of the lands toward the shore, the fill thus created required a connection between it and the shore. This was accomplished by constructing an earth-fill embankment, called a causeway.

In Fig. 1 is shown the extent and shape of the terminal as well as its relative location in New York harbor. The entrance channel is 600 ft wide at its minimum, and the side channels are 300 ft, both bottom widths. All channels are 35 ft deep at mean low water. The length of bulkhead surrounding the area is about 9,300 ft and the filled-in area comprises some 150 acres. The connecting causeway is about 5,000 ft long with a top width of 100 ft. Its use has been apportioned to provide a 33-ft railroad right of way, and 67 ft for highway purposes and for installing overhead and underground utilities. Shore entrance to the terminal for the present is by way of the causeway from the street system of Bayonne.

For the bulkhead the relieving platform type was selected, as shown in Fig. 2, with modifications for this particular project. The pile cutoff was set slightly above mean low water, necessitating a fill of about $7\frac{1}{2}$ ft above the platform. It was estimated that the dead load on the platform would be about 750 lb per sq ft and, since it was contemplated to have railroad tracks, as well as future crane equipment, it seemed advisable to provide for a live load of 750 lb per sq ft, or a total of 1,500 lb per sq ft.

In the design, the piles were counted upon to carry a safe load of 15 tons each, or to sustain a load over an area of 20 sq ft. The pile bents were spaced 5 ft on centers and each bent comprised a row of 12 piles spaced on 4-ft centers, with the exception of the four outer piles, which were spaced closer. In addition, two batter piles were driven in each bent, as shown in Fig. 2. In the rear of the platform the usual waling pieces reinforced the solid tongue-and-groove sheet-piling. On the front of the bulkhead was erected a concrete retaining wall faced with oak fendering, to which the mooring bitts were securely bolted. On both sides of the sheet piling under and in the rear of the platform a bank of stone riprap was laid, averaging 16 cu yd per lin ft of bulkhead.



CONSTRUCTION OF RELIEVING PLATFORM, AT CORNER

INSIDE OF SINGLE-STORY SHED SHOWING SIMPLICITY OF CONSTRUCTION AND ROOMINESS

The design provided for untreated piles. Batter piles were generally driven to design lengths. The rest of the construction of the bulkhead followed conventional design and methods, caps being 12 by 12-in. and decking 6 by 12-in.

Material dredged from the channels by the hydraulic process was used for the fill. The first 12 to 14 ft of dredging was soft mud; the remainder consisted of a mixture of sand, gravel, and small boulders, although in some places large numbers of boulders of considerable size were caught in the stone box of the hydraulic dredge. In filling within the bulkhead, considerable care was taken to deposit the best sand and gravel over the platform and in the area immediately adjacent to the bulkhead. In the process of dredging, the mud was mixed with the sand and gravel, but a considerable amount of the lighter material remained in suspension until the overflow reached the area west of the terminal and north of the causeway over submerged lands. The fill was carried to about 11 ft above mean low water at the bulkhead, sloping to about El. 12 to 13 in the center.

The total quantity of dredging for the entrance and side channels was about 8,000,000 cu yd. The fill over the terminal area proper amounted to approximately 6,250,000 cu yd, the remaining 1,750,000 cu yd being utilized for the construction of the causeway.

Dredging the channels was a simple hydraulic operation. The side slopes of the channels on the far side of the bulkheads were dredged to a natural slope, which approximated 3 to 1. The method adopted to excavate the bulkhead trench is of interest. At first, it was thought possible that a dredge of some kind could excavate the trench with a specified rear slope of $2^1/_2$ to 1. This method was tried but found unsatisfactory; it was discovered that if the cutter of the hydraulic dredge was placed 10 to 15 ft outside the face of the bulkhead at a depth of 30 ft, the material would take its natural slope, approximating 3 to 1. The entire bulkhead trench was, therefore, constructed in this manner with the exception of an experimental section of 300 or 400 ft.

Filling of the causeway proceeded simultaneously with dredging of the bulkhead trench and construction of the bulkhead. The building of the causeway began at its junction with the fill area and continued westward to the shore line. Its original design contemplated a 100-ft width at the top and a 500-ft base, with an average height of 17 ft above the existing bottom of the bay. This gave side slopes of about 12 to 1. At the very beginning of dredging operations it was realized that, since the first dredged material was being deposited in approximately 5 ft of water, the side slopes would probably be much flatter than planned. So, inasmuch as it was reasonably certain that there would be an excess of dredging over fill, the discharge pipe of the dredge was placed on the center line of the causeway and the material permitted to take its natural slope. There being no need for economizing on material, this was deemed the safest and most practical way to construct the earth embankment, at the same time facilitating its later maintenance.

Results have justified this procedure; the causeway is very stable and suffered no damage whatsoever during the hurricane of September 1938. Although the crown of the causeway was held to a width of 100 ft, side slopes resulting from the method of construction were about 30 to 1; consequently, the causeway now has a width of base of 1,000 ft instead of 500 ft.

A bituminous macadam highway was constructed on the crown of the causeway with a width of 20 ft and 5-ft shoulders. This type of pavement was adopted because it was not deemed advisable to construct a concrete road until several years had elapsed, or sufficient time to permit the fill to take its maximum settlement. Meanwhile this pavement is proving very satisfactory and appears to sustain without injury loads of 18 tons per truck.

Prior to designing the bulkhead, 23 wash borings, at about 1,000-ft intervals, were made along the approximate line of the bulkhead and in the approach channel. Samples were taken showing the varying character of material. They indicated the surface of fine sand to be at El. −20 and −30, generally increasing in coarseness and density with greater depths. Thirteen test piles were also driven at intervals along the proposed line of the north and east bulkheads. From a study of all the data it appeared clear that piles driven to El. −50 would meet ample resistance to carry the design load. The adopted design (Fig. 2) called for piles ranging from 60 ft long at the face of the bulkhead to 40 ft at the rear, averaging about 50 ft, and providing about 20-ft penetration below the slope of the excavated bulkhead trench. This design proved, in general, satisfactory.

However, on the south side of the terminal, at a point approximately midway between the pierhead line and the western end of the bulkhead, it developed during the pile driving that piles of design length were not meeting proper resistance. Evidently a deep stratum of soft material was being encountered; reliability no longer could be placed on bearing piles of design lengths, and the writer concluded for reasons of economy to depend on the friction of the piles to sustain the load required.

As is customary under such conditions, the only safe procedure was to make a load test to determine the safe

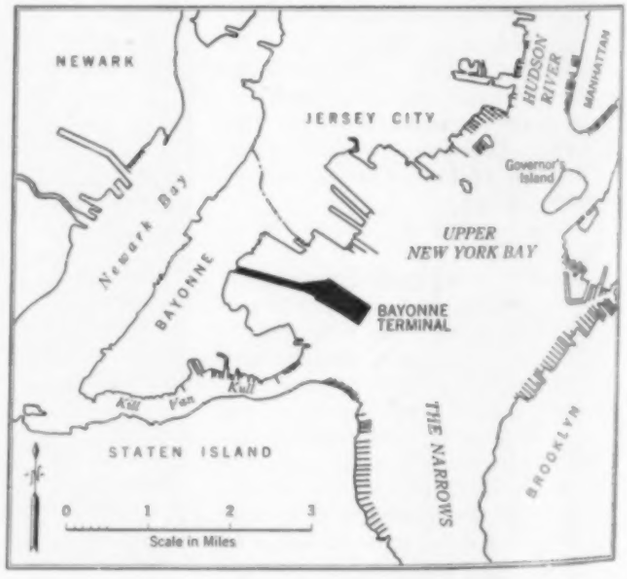


FIG. 1. LOCATION PLAN OF BAYONNE TERMINAL, NEW YORK HARBOR

carrying capacity of each pile and the length of the pile required. As a preliminary to this, a few test piles were driven at intervals along the south bulkhead trench to locate the point at which the maximum depth of the soft material occurred. At that point two 75-ft piles were driven to about El. −60, with a penetration of about 30 ft. The loading platform rested on the two piles to be tested and was so braced that it was free to move vertically any distance but laterally only 3 to 4 in. The platform was loaded with 60 tons of pig iron, 30 tons per pile, which was twice the design load. Readings were taken before loading, during loading, and for several days after the load had been applied. The maximum settlement was 0.74 in. on one pile and 1.14 in. on the second pile. Upon removing the load there occurred a rebound of 0.50 in. and 0.78 in., respectively, a net settlement of 0.25 and 0.36 in., which was not in excess of good practice.

The load test showed conclusively that piles with a penetration exceeding 30 ft, acting as friction piles with little or no end bearing, would carry the required load. For the guidance of inspectors and contractors, a practical formula was devised permitting a reduced resistance to pile driving with increase in penetration and in frictional pile surface. Piles with less than 30-ft penetration were considered as bearing piles, the Engineering News formula being applied. For greater penetration, as friction piles, the requirements were as follows, using a McKiernan-Terry 11-B-3 hammer:

Penetration in Feet	Blows per Last Foot, Not Less Than
30–35	6
35–39	4
Above 39	3

For the bulkhead the design provided an average of 16 cu yd of riprap per linear foot, but on the south side of the terminal, where the soft material was encountered, as much as 25 and 30 yd was required. This was because the natural slope of the material in the bulkhead trench was much flatter and the riprap was settling into the bottom to a greater depth than anticipated. Limited funds required the making of further studies of the riprap section in order to economize wherever possible. As a result, the section of riprap on the fill side of the sheet piling was reduced.

Finished Apron Between Quay Wall and Shed

As the placing of the riprap progressed beyond this section, it was found that the elevation of the sand stratum rose, requiring less riprap. On the east and north sides of the terminal, the bottom was practically all sand; it was then possible to recoup for some of the excess riprap quantities placed on the south side. Final computations showed that an average of 15.9 cu yd of riprap per linear foot of bulkhead was placed for the 9,300-ft length of bulkhead constructed, or within 0.1 cu yd of the amount originally planned.

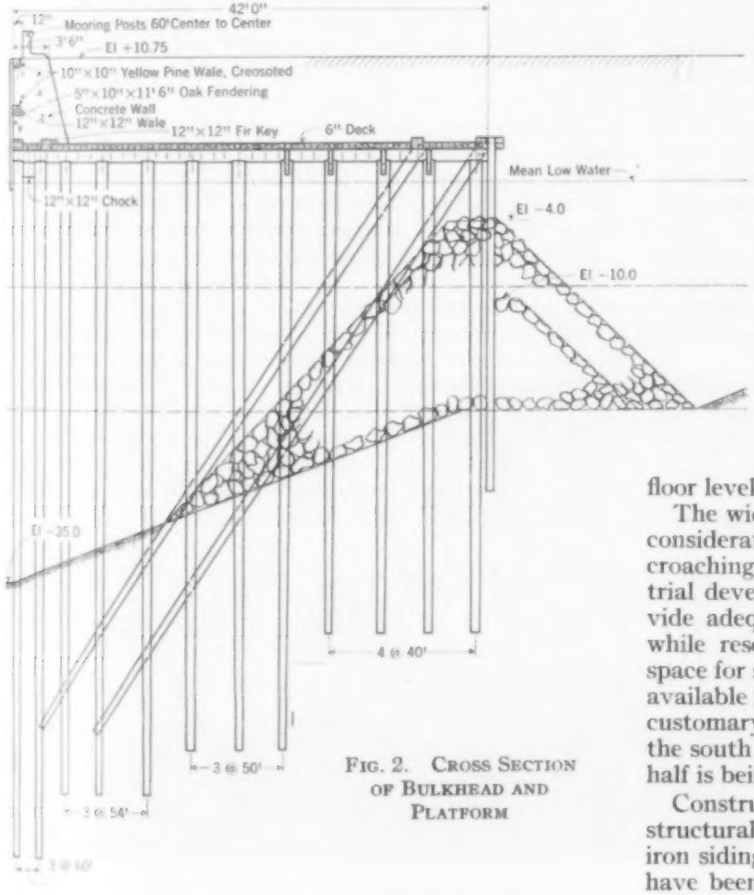


Fig. 2. Cross Section of Bulkhead and Platform

In planning the first transit shed, consideration had to be given to the type of operation contemplated and to the area available within an economical distance of the face of the bulkhead. After many studies, it was decided to build a one-story shed 1,000 ft long and 140 ft wide, with only one row of columns through the center. The channel side was fixed on the rear line of the bulkhead platform over the sheet piling, necessitating the design and construction of a special concrete beam to carry the load of the columns to the platform.

In the rear of the shed and at the same floor level a roadway 30 ft in width runs the entire length of the shed. Beyond this roadway a depressed railroad track will permit the loading and unloading of box cars at the floor level of the shed.

The width of the shed, 140 ft, was determined by two considerations: first, it was necessary to avoid encroaching unnecessarily on the area set aside for industrial development; and second, it was desirable to provide adequate width to permit stevedoring operations, while reserving within the area of the shed sufficient space for ship-side storage. As constructed, there is now available for stevedoring and for holding cargo within the customary free time period, not only the 40-ft apron but the south side of the shed, 70 ft in width. The northern half is being used for the storage of goods in transit.

Construction was not complicated. The shed is of structural steel with a composition roof and corrugated iron siding. The doors, of the rolling type, 13 by 20 ft, have been placed in pairs at every alternate 40-ft bay.

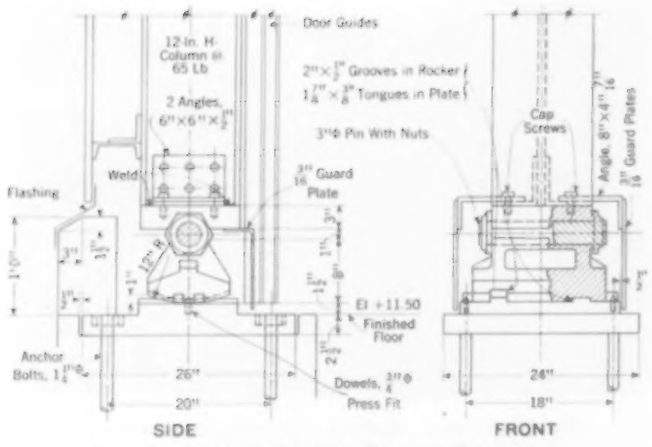


FIG. 3. PIN-AND-ROCKER COLUMN BASES FOR SHED—TWO ELEVATORS

The floor is bituminous macadam with a 1-in. wearing surface, cold mixed. This type was selected as more economical than a wooden floor and much easier to repair than concrete. It has proved highly satisfactory and future sheds will undoubtedly be built similarly.

Roof loads are carried by cross trusses bearing on the side and center columns. As the center columns are 40 ft apart, the cross trusses between them are carried by a trussed girder bearing on the center columns of the shed. Proper provision was made in the design for snow loads and wind loads.

In connection with the construction of the shed, a 100,000-gal water tank 140 ft high was erected; also a dry-sprinkler system on the basis of one sprinkler nozzle for every 100 sq ft of roof surface. Fire protection is of course further provided by an adequate number of hydrants distributed along both sides of the shed.

The structural steel design of the shed followed more or less conventional lines with the exception of the seating of the columns for the south side of the shed. It was expected that some movement of the bulkhead, both laterally and vertically, might take place, and since these columns were being supported directly by the rear piles of the bulkhead, it was deemed advisable to ensure that no movement would seriously affect the columns. This was accomplished by providing a pin and rocker seat for each column, as shown in Fig. 3. With this arrangement, it was estimated that the bulkhead could move laterally 4 or 5 in. without disturbing the vertical position of the column or endangering the roof truss.

Within the transit shed the handling of commodities has been simplified and made less expensive by omitting the transverse rows of columns which interfere with the proper manipulation of cargo. By handling truck traffic on the 30-ft roadway along the shore side of the shed, the amount of truck traffic within the building is reduced and a larger percentage of the area of the shed is released for storage purposes.

Although the entire floor of the shed is constructed over the filled area, the loading on some parts totals 600 lb per sq ft, with goods averaging 60 lb per cu ft. With goods of a greater density, the floor of the shed can be safely loaded to 1,000 lb per sq ft. The possibility of a high unit load is a great advantage in comparison with the limitations of 250 to 300 lb per sq ft imposed at most piers and warehouses.

Use of the terminal began about March 1, 1939; obviously, there are still many problems of operation to be ironed out and finally determined upon. It is the intention, however, to lease sites within the industrial area to corporations engaged in manufacturing that require accessibility to deep water, with a proper coordination of rail and highway service. Facilities for transshipment are offered in various ways, conforming in general to the present practice in New York harbor. Ships are accepted for mooring purposes on a day basis, and goods are accepted for storage under prevailing storage rates. However, leases for certain berthing facilities on annual leases for a definite amount of space are offered. The usual stevedoring and handling of goods is at present performed by contract, but serious consideration may be given to the performance of these various services with the terminal forces.

Because of the limited funds available for construction, the covered area of the terminal at this time comprises only one transit shed of 140,000 sq ft. This is, of course, a serious deficiency and the erection of additional sheds is imperative to accommodate the handling of business gradually flowing to the terminal.

Up to January 1, 1940, the terminal had accommodated 35 ships and had expeditiously handled 97,000 tons of commodities inward and outward. The shed itself has been practically 60% occupied with temporary ship-side storage, the other 40% being fully utilized for the discharge of ships and the retention of the cargo during the usual free period of ten days.

The total cost of the terminal, inclusive of legal and engineering fees, interest during construction, preliminary expenses and incidentals, but exclusive of lands, aggregates $4,050,000. The design of the project and the supervision of the various construction contracts were carried on under the direction of the writer as consulting engineer for the city. The original designs for the bulkhead were submitted by Charles W. Staniford and approved by Arthur S. Tuttle and George T. Hand, all Members of the Society; those for the transit shed were prepared by the firm of Parsons, Klapp, Brinckerhoff and Douglas, with E. E. Halmos, M. Am. Soc. C.E., chief engineer. Field engineers were J. J. Cunningham and James Italiano. A. L. Sherman, M. Am. Soc. C.E., was principal assistant engineer, and made helpful suggestions in the preparation of this paper.

COMPLETED AND IN USE—SOUTH SIDE OF TERMINAL

West Third Street Vertical-Lift Bridge in Cleveland, Ohio

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IMPROVING the Cuyahoga River in Cleveland for navigation involved also a number of street and bridge readjustments, such as the replacement of an old swing span on busy West Third Street. In its place a 225-ft vertical-lift span was built. During construction, traffic used a by-pass including an ingeniously operated pontoon swing bridge. For the new bridge, problems of sinking cylindrical steel foundations 160 ft deep below water level, with the footings in solid rock, and of operating the lift structure, are especially important. The bridge went into use on May 28, 1940.

ONE of the large projects being carried out by the city of Cleveland aided by the Federal Public Works Administration is the Cuyahoga River Improvement. It provides for the straightening and widening of the navigable channel of the river to facilitate the movement of the large amount of iron ore and other shipping commodities destined for up-river industrial plants and docks. This work made necessary the reconstruction of a number of structures over the Cuyahoga River, among them the Upper West Third Street Bridge.

West Third Street is the principal north-and-south thoroughfare cutting the river valley and connecting the downtown business section of Cleveland with the industrial section further up the river. The new structure replaces an old center-pier iron swing span built more than fifty years ago. Since it serves the city garbage and rubber incinerator plant recently completed near by in addition to the steel plants and other industries, it will carry a heavy traffic.

NEW AND TEMPORARY MOVABLE SPANS ARE COMPLETELY DIFFERENT

A vertical-lift span provides a 200-ft clear channel with a vertical clearance of 97.3 ft above low water datum as required by the U.S. War Department regulations. As regards live load, the structure was designed for the Ohio State Highway Department H-20 loading, but in all other respects the design followed the American Railway Engineering Association Specifications for movable bridges of this type.

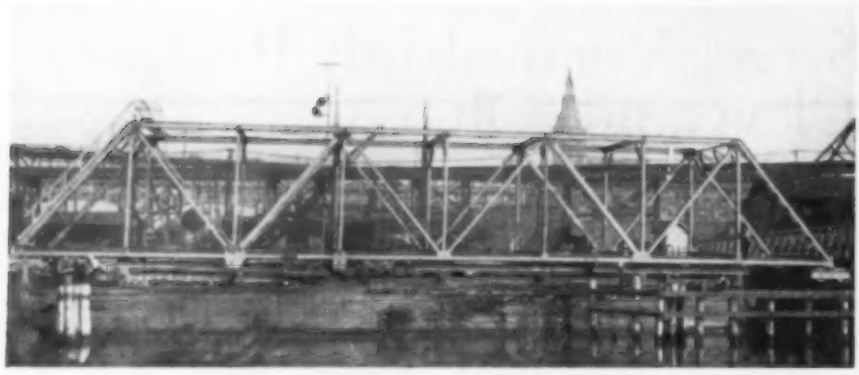
Owing to the heavy traffic on this street, it was necessary that both river and street traffic be maintained during the construction period. Hence provision had to be made for a highway crossing while the old structure was removed and the new one built. For this purpose a temporary structure including a pontoon swing span was constructed, directly downstream from the permanent bridge.

This swing span was a through riveted truss 128 ft long, with a double-lane roadway and one 4-ft 6-in. sidewalk, also wood pile and timber approaches, all with steel roadway stringers and plank floor. The span was electrically operated in a maximum time of $2^1/_2$ minutes and provided a clear channel of 87 ft. The fixed corner of the movable pontoon span was supported on a cast-steel ball-and-socket joint, while the opposite corner at the same end was carried on a two-wheel equalizing carriage rolling on a heavy steel railroad rail curved to the required radius. The entire end of the movable span, like the rest of the temporary structure, was supported on a wood pile and timber pier.

When closed and carrying highway traffic, the swinging end of the pontoon span was also supported directly on a timber pier; but when open or opening, this end was carried by a steel pontoon barge at four points—two under each truss at the second and third panel points from the swinging end of the span. The pontoon barge was divided crosswise into three parts with openings for draining water from the end compartments to the center one. The center compartment was equipped with two electrically operated gate valves and with one hand-operated valve to allow the water to enter from the river, and also with two turbine-type pumps capable of discharging 750 gal of water per minute from the pontoon. This control of the flotation level allowed the operator to lift the end of the span from the pier for opening and to lower it on the pier when closing.

The turbine pumps and the electrically operated gate valves taking water from the river were controlled from the operator's cabin on the pontoon barge. This also contained equipment for operating the river signals, as well as the temporary crossing lights and signals. It was also equipped with an electrically operated double-drum

THE NEWLY COMPLETED WEST THIRD STREET BRIDGE
Span Up, Pontoon Span and Temporary Structure Shown Below



TEMPORARY PONTOON SPAN, LOADED ON BARGE, BEING FLOATED INTO PLACE

40-hp cable hoist for swinging the span. From these drums ran steel cables so arranged and anchored to pile clusters that by hauling in on one and paying out on the other the pontoon span could be swung through about 90° to open the channel for navigation. Such operation of the span proved very satisfactory, covering a considerable portion of two navigation seasons.

THE PONTOON SPAN IN PLACE, RESTING ON THE PONTOON BARGE

Test borings, taken at the site before the plans were made, indicated a hard shale about 175 ft below the street surface or about 160 ft below the water level (low water datum, 570.5). The intervening material is largely clay of varying consistency. So it became necessary to establish the pier foundations in the hard shale about 175 ft below the bridge floor.

TWO POSSIBILITIES FOR PIER CONSTRUCTION

As designed the piers consist of concrete tops built inside of steel sheet piling cofferdams 45 ft long and 84 ft 6 in. wide. The river face of the north cofferdam is 58 ft high and that of the south one 48 ft high, the bottom of the sheet piling being stepped up 8 ft from the river side to the shore side of the pier. In each case the sheet piling was left in place to serve as the outside form of the concrete pier top and to be a permanent part of the substructure. The design for each pier provided for six cylindrical concrete shafts extending from the top down to at least 4 ft into solid bedrock. Four of these cylinders were to be on the river side of the pier under the front columns of the steel tower spans, and two were set back 30 ft from this front row, under the back line of the steel tower columns.

At their upper ends, adjacent to the pier tops, the cylinders were 6 ft in diameter. They were to be encased in steel sheet piling for a depth of 59 ft, and this provided a cofferdam for excavation as well as a form for the concrete cylinders. The footings of the two inside front cylinders were 6 ft in diameter with a 5-ft diameter for the remainder of their length, while the two outside front cylinders had a 5-ft diameter footing with 4½-ft diameter above. The footings of the two rear cylinders were 6 ft at the bottom and 5 ft above.

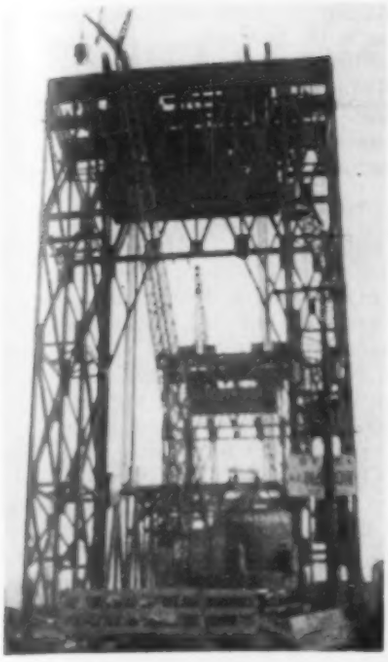
The specifications provided that in the excavation and construction of the concrete cylinders either steel sheeting or heavy wood lagging or segmental steel plate cylindrical rings should be used. Six batter piles, 16 in. in diameter and constructed of ⅜-in. steel filled with concrete and extending 10 ft below the bottom of the front row of steel sheeting in the cofferdams, were provided in each pier to aid in resisting the horizontal thrust of earth and wind in the direction of the river.

Proposals were also requested on an alternate type of pier construction consisting of six 30-in. welded pipe cylinders of ½-in. steel plate, with a 1¼-in. welded cutting edge. They were to be driven by steam hammers, excavated, and cleaned; then a 12 by 12-in. wide-flanged steel beam was to be placed in the center for reinforcement and the cylinder filled with concrete. The bids received were slightly less on this alternate type and the contract was awarded on that basis. First the cofferdam steel was driven and braced, and the interior material excavated to about 14 ft below the top of the steel sheeting. Then the steel cylinder shafts were sunk down to the required depth. After the pier cylinders had been excavated to the specified depth into the hard shale, a 1½-in. diameter rock core 6 ft long was taken from the bottom and the character of the rock bearing was approved before the placing of the concrete for the cylinders was begun.

To provide a 200-ft clear channel for navigation required a movable channel span 225 ft from center to center of front tower columns, with two 30-ft counterweight tower spans. These in turn are flanked with filled and paved approaches on which are located the traffic and barrier gates, guard houses, traffic signs, and signals. This gives a total length of superstructure of about 480 ft, including approaches.

The vertical lift span is a through riveted Warren-type truss, of 12 panels, 217 ft between centers of bearing. Its depth varies from 28 ft at the ends to 39 ft at the center of the span. The trusses are 46 ft apart center to center. All material in the main sections of truss members is of silicon steel to reduce the weight of the lifted span. The floor system and bottom lateral sys-

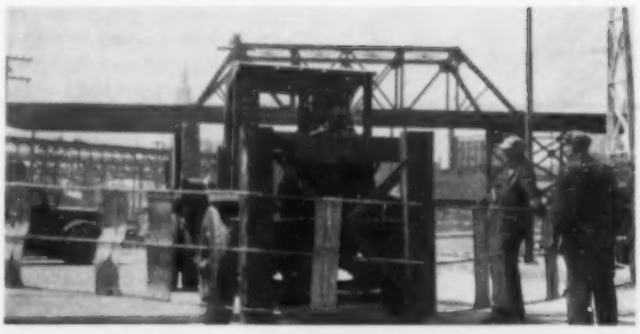
SHEAVES IN PLACE ON TOP OF TOWER BEFORE PLACING OF ENCLOSURES



CONCRETE BUCKET SUSPENDED ABOVE TOWER ON BOOM OF CRAWLER CRANE
Counterweight Concrete and Floor Slab for Top of Tower Spans Were Placed in This Manner

tem are of special corrosion-resisting steel and the remainder is copper bearing carbon steel.

For the four lanes required, the roadway is 42 ft between curbs. It is constructed of $4^1/_4$-in. concrete-filled, steel I-grid with a 3-in. crown. On each side is a 5 ft clear sidewalk of similar construction using 2-in. T-grid. All the drainage is to the roadway gutters, where cast-steel scuppers and down drains are provided of a length sufficient to keep water from the under-floor structural steel. In fact, no drainage is allowed to reach the concrete of the pier.



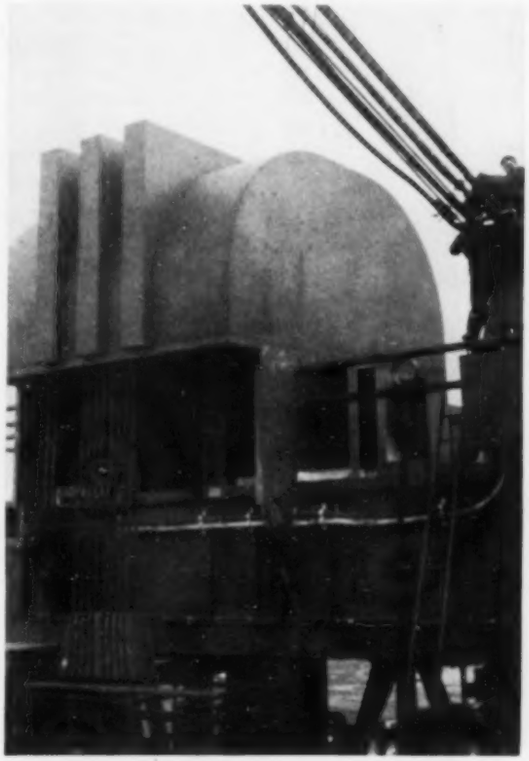
THE BARRIER GATES STOP A HEAVY TRUCK FROM 25 MPH
The Timbers Against the Net Were Attacked to the Truck to Protect It from Damage Under Repeated Tests

Of course the live load on the lift span is transferred directly by the end pedestals to the piers, but the dead load is counterweighted and suspended at each corner of the span by 16 steel cables 2 in. in diameter carried side by side over a cast-steel sheave 12 ft 6 in. in diameter supported on the river side of the towers. These counterweight sheaves have nickel steel shafts 21 in. in diameter turning on self-aligning spherical-type roller bearings at each end. The eight roller bearings are mounted with a press fit on the 18-in. diameter bearing end of the shaft. These roller bearings are the only installation of this type on the several movable bridges in the city.

The counterweights are structural steel boxes filled with concrete. Each has seven compartments in which portable concrete blocks will be placed to provide adjustment for the weight of the lifted span. Each counterweight box is constructed so that the entire counterweight may be suspended from the tower by forged steel eye-bars in the event that it becomes necessary to relieve the load on the counterweight cables, at which time the span itself would be jacked up from the piers.

An auxiliary counterweight is provided in the north tower with four $1^3/_8$-in. diameter cables running over two sheaves to the top of the rocker mast at the center of the lift span. The mast in turn has four similar cables of fixed length anchored to the south tower. This counterweight serves to equalize the unbalanced weight of the 2-in. ropes during the operation of moving the span. The fixed-length cables also support the power and control cables leading from the south tower to the rocker mast and thence down the mast to the machinery and control rooms.

The tower spans adjacent to the lift span and supporting the counterweight sheaves are 30 ft in length by 69 ft in width. Each consists of eight steel columns braced with riveted steel members in four vertical planes longitudinally and in four vertical planes transversely. The columns extend about 90 ft above the top of the pier and support trusses 30 ft deep; they are spliced about midway. Surmounting the 30-ft tower trusses (which are at right angles to the roadway) are continuous plate girders 5 ft deep, into which are framed the girders and beams supporting the sheave bearings and the floor system at the top of the towers. Stairs and walkways on the span and towers provide access from the sidewalk floor to all machinery, operating and counterweight cables, electrical equipment, lighting, navigation, and traffic signals.



COUNTERWEIGHT SHEAVE ENCLOSURES
At Right Can Be Seen the Power and Control of Cables from South Tower to Top of Center Mast

For operating the movable span, the main motive power is two 125-hp totally enclosed, 3-phase, 60-cycle motors connected to hoisting drums located at the center of the lift span. The drums wind two $1^1/_8$-in. diameter uphaul cables, and in the reverse direction two down-haul cables extending along the top chord to the tower columns adjacent to each roadway truss. The uphaul ropes then extend up the tower columns to the tops of the towers, and the down-haul ropes extend down the tower columns to enclosed takeups just above the sidewalk floor.

At each corner of the span is a limit switch designed to cut off the electric current and set brakes at the fully closed position of the span, while at the middle of the lifting girder at each end of the span is another limit switch to cut off the current at the fully

DEFLECTOR SHEAVES, CARRYING TWO "UP-HAUL" AND TWO "DOWNHAUL" CABLES

open position of the span. The machinery is further provided with limit switches to stop the moving span about 3 ft above the fully closed position and also about 3 ft below the fully open position. The operator then eases the span into its final position. Pneumatic buffers are provided below the floor at each corner of the movable span to ease the approach of the span to the fully closed position and to avoid shock as the span comes to a final seating.

Span locks at each corner of the span lift just above the main lifting girder are provided at the fully closed position. These are operated through shafts by 3-hp enclosed squirrel-cage motors with helical worm-gear speed reducers equipped with electric power brakes and hand cranks for emergency operation.

In the event of failure or interruption of the regular electric power, auxiliary power is provided by one 115-hp 6-cylinder gasoline engine installed in the machinery house (geared to the regular operating mechanism.) It is equipped with a marine reversing unit and has provision for starting and controlling the engine from the control bench in the operator's house. Thus the operator need not leave his station at the control bench. To provide further for emergencies, an auxiliary 6-cylinder, 78-hp gasoline engine with a 44-kva electric generator is installed in the machinery house, with its entire starting and operating control in the operator's house. An emergency light, energized by current from a storage battery circuit, is placed in the operator's house to serve until the emergency generator is in operation.

Air whistles for navigation signals are operated from the control bench in the operator's house; one points upstream and one downstream for signaling river traffic. These whistles are motivated by compressed air furnished by two electrically operated automatically controlled compressors.

For signaling the guard-house watchmen and street traffic, two electrically operated automobile-type horns are erected over the roadway below the machinery house floor. Each direction of traffic has its own horn individually operated from the control bench.

Street traffic is controlled by a "Bridge Open" sign mounted on metal standards back of the curbs and about 300 ft in front of each tower span. There is also a standard U.S. Bureau of Public Roads traffic sign reading, "Traffic Signals Ahead." A red and green vertical, one-way traffic signal with a warning bell above is mounted over the roadway on the front face of each barrier gate portal, all controlled from the control bench in the operator's house. The warning bells are automatically turned on as soon as the red traffic sign is energized and stop ringing when the barrier net is down.

PRECAUTIONS FOR SAFETY

Yielding roadway barrier gates (with sidewalk arm extensions) are installed a short distance from each tower span and are capable of stopping a 20-ton truck moving at a speed of 25 miles per hour within a distance of 22 ft. In addition to the barrier gates, and about 11 ft in front of them, are installed roadway traffic gates. They are automatic and electrically operated in a vertical plane as at railway crossings. Counterweighted arms cover half the roadway, and each has three warning lights with flashing "On" and "Off" signals. The circuits are so arranged that adjacent lights on the traffic gates and on the barrier gates will flash "On" and "Off" alternately.

Navigation signals, street lights and signals, traffic gates, barrier-gate nets, span locks, and operating mechanism are all interlocked and controlled from the operator's control house. However, the barrier gates and span locks may be by-passed and manually operated for emergencies.

The Cuyahoga River Improvement is being carried out by the City of Cleveland through the Department of Public Service; Miles E. Evans, director; Robert Hoffmann, Hon. M. Am. Soc. C.E., consulting engineer; John C. Wenrick, commissioner of engineering; George B. Sowers, M. Am. Soc. C.E., consulting engineer, Cuyahoga River Improvement; Mark Starkweather, resident engineer; Wendell P. Brown, M. Am. Soc. C.E., consulting bridge engineer, West Third Street Bridge; Marvin Sanger Brown, Assoc. M. Am. Soc. C.E., principal assistant. The improvement is sponsored by the Federal Emergency Administration of Public Works, John M. Carmody, Federal Works Administrator, under the direction locally of William E. Janney, chief resident engineer inspector, Cleveland. The contractors are the Western Foundation Company, Chicago, for the substructure, and The R. C. Mahon Company, Detroit, Mich., for the superstructure, including the temporary structure.

TOP OF PIER, SHOWING STEEL GUTTER AND DRAINS AT ROADWAY EXPANSION JOINTS
Note the Steel Sheet Piling of the Cofferdam, Left in Place, and Outside It the Steel Bulkhead

Design of Hiwassee Dam—Engineering Details

By CECIL E. PEARCE

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PROJECT DESIGN ENGINEER, HIWASSEE DAM, KNOXVILLE, TENN.

SUPPLEMENTING his general description of this important unit of the TVA program, as given in the June issue, Mr. Pearce here confines himself to those details that differ from previous practice. He takes his fellow engineers into the designers' confidence in citing the failure or success finally achieved with regard to such problems as keyways, water seals, roadway and upper details, and the outdoor power plant. In particular, the idea of perforating the bottom of the steel gates to relieve pressure, and the discussion of successful procedures in concreting will interest all engineers. The complete paper, from which this and the earlier article were abstracted, has been placed on file in the Engineering Societies Library, in New York, N.Y.

NO two dams are designed alike. Differences in basic conditions account for some variations in treatment while others are due to advances in the art which make possible more efficient procedures. So it was in the case of Hiwassee Dam. Most of the design yielded to standard treatment but a number of innovations were investigated, of which many proved feasible and were found to be improvements, at least under the conditions on this job. These details will be described briefly. The more general features of the dam, which is 307.5 ft high along the axis of the dam (maximum height 322 ft from lowest point in foundation to top of roadway), 1,285 ft long at the crest, and contains 795,000 cu yd of concrete including appurtenant works, were covered in the June issue. While the principles of design here presented are for Hiwassee Dam, they might apply equally well to almost any other high dam having the same requirements.

In order to secure relief from uplift, Hiwassee Dam is provided with inspection galleries as near to the foundation as practicable, as shown in Fig. 4. (See preceding article for Figs. 1 to 3.) A minimum gallery size of 6 by 9 ft was adopted, to accommodate the grout-hole drilling machine. The roof of the galleries, instead of having the usual semicircular shape, has a flat top with 12-in. radii in the top corners. Straight horizontal reinforcing steel over the galleries, regardless of their shape, was found to be more effective than curved steel; this arrangement is rational in that the steel is then normal to the most likely cracking planes, which are always nearly vertical.

All gallery light conduits were placed in the open, installed against the roof or sides of the gallery after the forms were stripped. This is because in the past it has been found easier to keep such wiring dry and free from short circuits if placed in the open.

Where the galleries cross contraction joints, the corners were chamfered 1 in. wide by $^3/_4$ in. deep on the sides and roof to prevent spalling. The joints at the floor were rounded on a $^1/_4$-in. radius as in sidewalk practice.

Keys were placed approximately on the lower one-third of the area of each contraction joint, some of the details of which are shown in Fig. 4. The keys were inclined parallel to the downstream face of the dam or approximately parallel to the principal stresses, on the theory that if the reentrant corners of the keys had any effect in determining the location of cracks, such cracks would be parallel to the principal stresses and therefore be in the least harmful position. Actually, however, the cracks that did appear disregarded these inclined keys and formed in almost truly vertical lines.

As a matter of fact, the keys were put on the lower one-third of the area as a compromise. One school of thought favored the complete elimination of all keys on the contraction joints, as being unnecessary, costing less, and eliminating most if not all of the difficulties encountered in connection with twist where a high cantilever is adjacent to a much lower one. The other school of thought favored keys on the contraction joints on the general principle that the structure as a whole should be as nearly monolithic as possible so that sections on weaker foundations would bridge over and be supported on stronger ones. The parts of the contraction joints that were keyed were grouted according to somewhat usual practice.

Each contraction joint was provided with a 20-gage stainless-steel vertical water stop, as shown in Figs. 4 and 5, Type *A*. The seal fits on the downstream side of a vertical 6-in. round formed well, with its 12-in. wings embedded in the concrete on each side. The circular part of the seal is painted with grease before concreting. Water enters along the contraction joint to the 6-in. well, which it fills, and when the joint opens, the curved part of the seal acts in bellows fashion, moving slightly upstream into the open well into such a position that the seal has

LOOKING NORTHWEST FROM UPSTREAM BULKHEAD, SHOWING PENSTOCKS UNDER CONSTRUCTION AND INCLINED KEYS ON CONTRACTION JOINT

a little longer radius. Thus it moves back and forth as the joint "breathes." This particular seal, without any sharp reentrant corners, is designed for ease in making field joints, which are welded.

At each horizontal construction joint, or at the top of each pour, a horizontal seal (Type *C*, Fig. 5) is extended from the wings of the vertical water seal out 3 ft into the concrete on each side of the vertical seal. During construction, the contraction-joint faces in the dam cool off more rapidly than the center of the blocks so that there is a tendency for the construction joints to open somewhat for a short distance back from the contraction joint faces. These horizontal seals are installed to minimize the tendency for water to by-pass, on the horizontal construction pour joint, around the normal vertical seal.

As shown in Fig. 4, 8-in. round formed drains are placed on the contraction joint to intercept any leakage that may get past the system of water seals. Between the drains on the contraction joints which are just downstream from the water seals, five other 8-in. formed vertical drains are placed in each block in the mass concrete of the dam. These drains, below the lowest gallery, line up with the drains in the foundation and generally are spaced on 8-ft 4-in. centers.

EMERGENCY AND INTAKE GATES PROVIDED

On each of the four regulating conduits there is one ring-seal gate, which is intended to be operated either wide open or closed. Rather than to provide a duplicate or secondary gate of the same design on each line, saving the upper one for emergency use only, it was decided to provide a steel bulkhead gate or "emergency gate" which could be lowered down the upstream face of the dam in front of any one opening by the gantry crane.

The essential difference between the method of operation of the emergency gate for the regulating conduits and the intake gates for the penstock is that there is only one emergency gate, which is normally stored in a recess of the concrete roadway, whence it is lifted out by a gantry crane and lowered in front of any opening. It may be left there if desired; handling is by means of a lifting beam which will engage or disengage under water.

In front of and over the top of each penstock opening, however, there will be an intake gate hanging in the water and operated by a fixed hoist in the top of the dam just under the roadway level. Only one such intake gate and hoist is to be installed at present, but another will be provided when the second power unit is built.

The emergency gate has over-all dimensions of approximately 18 ft in width by 18 ft in height, whereas the intake (or penstock) gate is 20 ft wide and 30 ft high. Both gates are nearly of the same design, having a structural steel frame, an endless chain of rollers, and a movable bronze sealing strip with stainless steel coil springs behind it. The seats on the gate frames are of stainless steel.

A unique feature of the gate design is the shape of the bottom steel girder or beam, which is perforated. It has been found that as a bulkhead-type gate nears closure, the water rushing past the lower corner assumes a vena-contracta shape and pushes up very little on the bottom of the gate. Therefore, the balancing upward pressure on the bottom of the gate is gone, and the lifting mechanism must lift not only the weight of the gate but also the hydrostatic pressure downward on top of it. Model tests made in the hydraulic laboratory brought out the following conclusions:

1. The maximum hydraulic load for the sluice gate with the lower beam solid and located at the bottom of the gate would be 158 tons.

PLANT FOR COOLING MIXER WATER DURING SUMMER MONTHS
Two Refrigerating Units in House, Condensing Coils Outside

2. With one or more of the lower beams perforated (and with the lower beam raised somewhat above the bottom), a maximum hydraulic load of 70 tons would result.

It is obvious that this procedure of perforating the bottom beam and lifting it slightly above the bottom of the gate cut the hydraulic load about in half and reduced the required hoist capacity about 80 tons. The intake gate may be closed by remote control from the power house, where its position is indicated on the switchboard.

The spillway is controlled by seven 23 by 32-ft Tainter gates, the crest of the spillway being at El. 1,503.5, the top of the gates at El. 1,526.5, and the roadway at El. 1,537.5. The gates are of structural steel with hollow-core rubber seals at both bottom and sides. The gate thrust is carried back into the spillway pier by a structural steel frame, and the design includes methods for jacking the trunion pins into proper position.

Normally the method of lifting the spillway gates is by means of a 120-ton gantry crane on top of the dam, which equipment is necessary for the operation of the emergency gates closing the upstream end of the regulating conduits or sluice outlets. This crane, together with a lifting beam, picks up the ends of the chains on the spillway gate, and a dogging device holds the chain, and therefore the gate, in any desired position. Then the gantry can be moved and used for operating other spillway gates or for some other service.

To insure continuous spillway-gate operation, there is also a gasoline-engine-driven hoist, which travels along at roadway level immediately downstream from the roadway. Each spillway gate is provided with an indicating device to show its elevation, which may be transmitted to the power-house operator by means of a nearby telephone.

GANTRY CRANE SERVES MULTIPLE PURPOSE

The gantry crane provided at the roadway level is used for lowering or raising the emergency gate in front of the regulating conduit; for operating the spillway gates if desired; for lifting the penstock intake gates from their normal upper position to the roadway or repair chamber when inspection or repairs are required; or for hoisting heavy equipment, such as ring-seal gate parts, or material under repair into or out of the equipment shaft to the gallery in the dam below.

The crane is operated by 440-v current supplied through a cable on a reel mounted on the crane and plugged into polarized receptacles at intervals along the dam. This arrangement obviates the dangers of an exposed trolley.

At the top of the dam there are a number of details which, though seemingly small, are of utmost importance for appearance, usability, and general satisfaction. The

roadway is 19 ft wide, and the sidewalks on each side are 4 ft wide. The curbs are made rather high (9 in.) in order to provide greater pedestrian safety by insuring against the possibility of an automobile's riding over the curb and onto the sidewalk.

The parapet is designed for visibility out over the lake or down the river gorge as seen from a vehicle driving across the dam. High solid parapets have in the past been unsatisfactory in this respect. An iron-pipe type of rail or an all structural rail was thought to be out of keeping with a high masonry dam, as well as unsafe. Therefore the parapet consists of a low concrete wall 12 in. thick and 26 in. high. On top are malleable iron brackets, spaced on approximately 15-ft centers, supporting a low, stocky 4-in. single standard pipe rail with flush joints. This design provides approximately 12 in. of visibility between the top of the concrete parapet and the under side of the pipe rail.

Light standards approximately 15 ft 6 in. high, and topped by 18-in. frosted spherical globes, are placed on the upstream parapet only, at a spacing of about 75 to 80 ft. Low indirect lighting from the parapet shining across the roadway was tried at Norris Dam and found to be unsuccessful because a driver crossing the dam at night experienced a very annoying flickering effect as the front corner windshield posts of the automobile passed each light.

At each horizontal construction joint on the downstream face of the dam, and above a certain low-water elevation on the upstream face, a horizontal chamfer was provided, as shown in Fig. 5, to cover up any inaccuracies in pouring from form to form, and thus aid the appearance. At present this procedure appears to have been very successful. The somewhat conventional vertical joint chamfers were also placed on each construction joint.

With regard to the concreting methods used at Hiwassee Dam certain points should be stressed. It is believed that on all high masonry dams built in the future the following precautions and methods should be employed:

1. Use of low-heat cement.
2. Adoption of low cement content.
3. A slow pouring schedule with long intervals between pours.
4. Refrigeration of mixing water in summer, and heating of it in winter.
5. The use of several low lifts of pour over rock foundations or old concrete.
6. Careful excavation of all humps or irregularities in the foundation, even though the rock may be good.
7. Cooling of adjacent faces by spraying for three weeks or more and, in special cases where high temperature differentials are to be expected, graduation of the temperature gradient by the use of cooling pipes properly spaced in the concrete.
8. Avoidance of high exposed contraction joint faces of concrete as far as possible.

LOGIC BEHIND PRECAUTIONS

Regarding the first and second precautions, it is believed that low-heat cement, in addition to liberating less heat on setting, also permits a sort of plastic flow during the setting period while the strength is still low. Then, too, the low cement content causes less strength and less liberation of heat. The diminished strength and slow setting caused by both these factors aids plastic flow. Therefore some of the contraction that would ordinarily cause stress is taken care of by a readjustment in shape. If enough of this contraction can be relieved by plastic flow, the part of the total contraction remaining to cause stress will be less, and cracks may not form. A slow pouring schedule of course also permits more loss of heat by radiation.

With regard to precaution No. 5, the reasoning is as follows. A study of Norris Dam showed that most of the

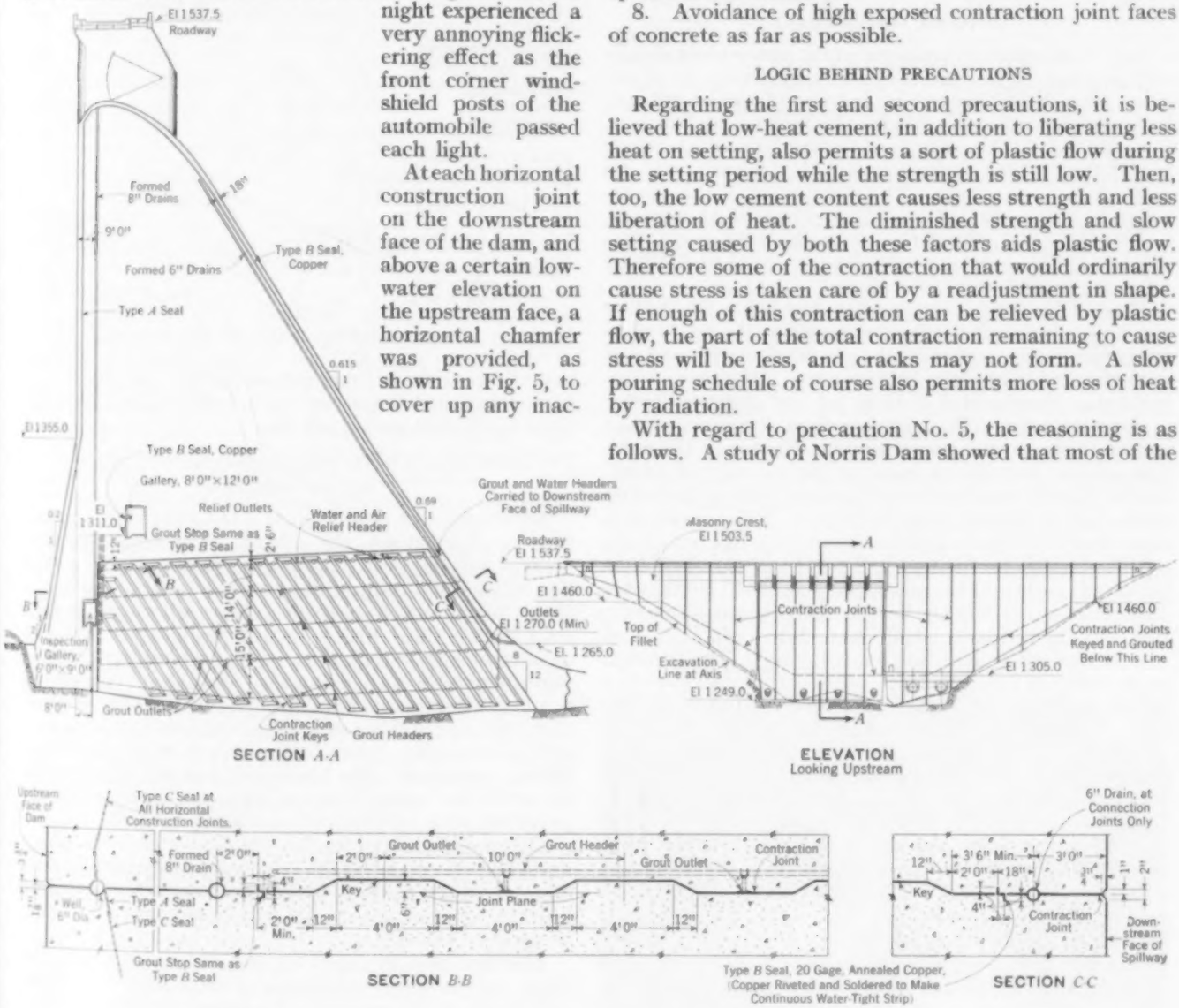


FIG. 4. HIWASSEE DAM—ELEVATION AND SECTIONS SHOWING WATER SEALS, KEYS, AND PROVISIONS FOR DRAINAGE

cracks occurred in new concrete poured on top of old concrete which had set for a long time, say 30 days or more. This led to the logical conclusion that there was too great a difference in temperature between the two. In other words the older concrete did not heat up much when the new was poured on top, whereas the new concrete did. Thereafter, when the upper concrete cooled off and contracted, the lower concrete could not contract any more (or only a very little more); then the upper concrete cracked because the tensile force of contraction was unrelieved owing to the relatively unyielding foundation, and the relatively short vertical cantilever.

If, on the other hand, the pouring is more or less continuous, the temperature gradient, though not uniform from the bottom to the top of a block, has at least no sudden changes in it, and the two portions on each side of an imaginary vertical cracking plane are uniformly pulled together, causing the two imaginary cantilevers to be deflected toward the common center with a somewhat uniform load (the tensile stress of contraction) from top to bottom. In such a case the temperature, and the consequent contraction and stress, has a chance to even out and automatically to inter-adjust itself, with possibility of plastic flow, so that cracks are less apt to form.

OUTDOOR POWER PLANT

Only brief comments on some of the power plant details will be given. The plant is at the downstream toe of the dam. One 80,000-hp turbine is being placed at present, but provision is being made for the future installation of a second unit. The plant is of the outdoor or open-deck type; that is, the generators are in the open with no power house over them. The elimination of the power-house building effected a saving estimated at approximately $108,000 considering only the first unit. The amount of this economy will rise to a total of $142,000 when the second unit is installed.

Most of the smaller equipment is put below the deck or top floor, which is at the same elevation as the roadway to the power house, so that trucks can drive up the road and onto the deck under the gantry crane. However, a control house, constructed of large pre-cast concrete blocks, is put above the deck upstream from the gantry crane runway between the generators and the toe of the dam. The outdoor installation imposed the necessity of adopting the gantry crane instead of the conventional traveling crane used in power-house buildings. This crane has a capacity of 275 tons in two hoists, and also has two 25-ton auxiliary hoists for lifting small parts and the draft-tube bulkhead gates. The generator has a 40-ft-diameter structural steel cover—a low, circular, turret-like structure having a $^5/_{16}$-in. steel skin plate—which can be moved as a whole with the gantry crane. The turret is approximately 2 ft high at the outer corner, and rises to a height of about 7 ft in the center over the exciter. The center part can also be moved separately.

A 28-ft by 30-ft rotor hatch, with a watertight cover, is also provided. Into it the rotor may be lowered to a solid pedestal on the floor 22 ft below, where it may be worked on in the dry after the hatch cover is replaced. A hatch of this size should be provided with liberal camber to insure drainage to the outer edges even after sag deflection due to its weight. The rotor hatch is also used when removing the main transformer core. The transformer is lowered through the hatch; the core is raised; the transformer is rolled to one side on tracks provided for it; and then the core is lowered again and the hatch cover replaced. When not in use the transformer transfer car can be retracted into a pit so that the floor of the car is flush with the deck, and out of the way.

Since the deck of the power plant forms the roof of the rooms below, it was necessary to make it tight against any possibility of leakage through small cracks. To accomplish this the deck was first poured up to within about 6 in. of the final elevation. Next a membrane of 3-ounce copper with an asphaltic coating on both sides was placed over the entire area, using lap joints cemented together with a hot asphaltic mastic. Then the final 6 in. of concrete was poured over the membrane.

The hydraulic installation includes an 18-ft diameter riveted-steel penstock, controlled by an intake gate covering an opening of 15 ft 2 in. by 25 ft 8$^1/_2$ in. from center

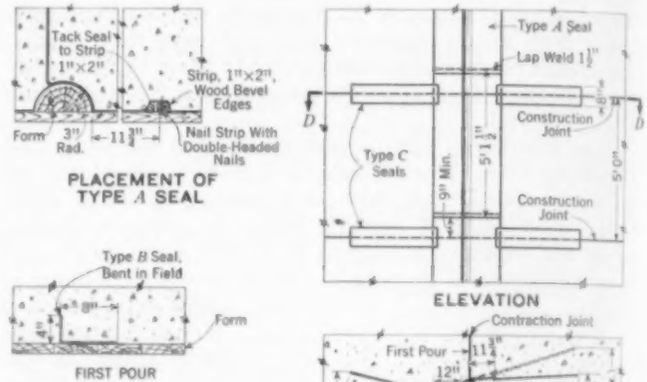


FIG. 5. DETAILS OF SEALS AND JOINTS

to center of seals; a Francis-type turbine; an elbow-type draft tube; and three draft-tube bulkhead gates for the three sections of each draft tube.

SWITCHYARD WITH TERRACED CONSTRUCTION ON NEARBY HILLSIDE

Adjacent to the power house is the switchyard, on four level benches cut into the hillside. A heavy concrete deflection wall has been placed along the top cut to protect the switchyard from rolling earth or rocks and to drain the surface runoff to one side. The vertical cut between each shelf is lined with a continuous concrete wall, the top of which is, in each case, used as a footing for switchyard structural-steel columns. Outside of the various concrete foundations required, the level benches are covered with fine crushed gravel and drained by a system of pipes discharging under the power-house access road to the tailrace below. For transporting heavy equipment to and from the various benches, an inclined tram or hoist is provided, with a fixed hoist on the upper bench.

This switchyard is on the left side of the dam facing downstream. Nearby, the left bank of the river, forming one side of the tailrace, is riprapped with heavy rock to prevent scour of that bank, which supports the power-house access road.

The dam was designed by the Tennessee Valley Authority under the general supervision of Barton M. Jones and Harry A. Hageman. The writer was project design engineer. The dam was built by force account under the supervision of C. E. Blee. All are members of the Society.

Design Features—Pennsylvania Turnpike

Safety Is Paramount Consideration in Planning Long Toll Road

By CHARLES M. NOBLE, M. AM. SOC. C.E.

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HIGH speed on the open road and safety of travel are usually considered incompatible. It remained for the Pennsylvania Turnpike to reconcile these conflicting factors. As Mr. Noble explains, every modern feature to safeguard travel was incorporated, with the result that a continuous speed of 70 miles an hour will be feasible throughout except on a few of the sharper curves. This paper, briefed from an address delivered before a meeting of the Philadelphia Local Section in January, details many advances in highway design.

SAFETY in vehicle operation is perhaps the most important factor in present-day highway expansion. It was made the keynote in the design of the Pennsylvania Turnpike. In providing this inherent safety a number of objectives were considered fundamental:

1. Separation of streams of traffic flowing in opposite directions to reduce the possibility of head-on collisions and side-swipe accidents.
2. Elimination of all highway and railway grade crossings, so that there will be no cross traffic.
3. Provision of wide, smooth, stable shoulders level with the pavement to enable vehicles to park completely off the paved area and to provide "elbow room" in cases of traffic emergency or mechanical failure.
4. Provision of two lanes of pavement in each direction in order to reduce the menace due to slow-moving vehicles, to eliminate the necessity of encroaching on the lanes of opposite-direction traffic when passing, and to obviate delay in passing.
5. Construction of traffic lanes of sufficient width to care adequately for the safety, comfort, and convenience of all classes of traffic.
6. Elimination of all frontage, "wildcat" commercial development, and local farm entry along the right of way, and the complete control of that right of way.
7. Exclusion of pedestrians.
8. Provision of moderate grades to increase safety during icy weather and to increase the speed of large heavily loaded trucking units so that rear-end collisions between fast and slow vehicles are minimized.
9. Arrangement for uniform and consistent operating conditions.
10. Provision of specially designed access facilities at reasonably long intervals, with acceleration and deceleration lanes in order that vehicles may enter and leave the main highway with reasonable safety and a minimum of traffic disturbance.

Considerable engineering discussion over the past several years has rather definitely established the desirability of each of these fundamental objectives as a matter of general policy in the design of express highways. All of them are incorporated in the completed design of the Turnpike, making it the first long-distance express highway in America to be so designed.

General design of the Pennsylvania Turnpike is illustrated in Fig. 1. The roadway cross section consists of a 10-ft medial zone which separates one 24-ft roadway carrying eastbound traffic from another carrying westbound traffic. Paved lanes are 12 ft in width, and the pavement is flanked with 10-ft shoulders on each side.

Design objectives 1 to 5 are thus attained. Elimination of all frontage and the complete control of the right of way are provided in the legislative act creating the Turnpike; the presence of pedestrians will be minimized, if not entirely eliminated, by fencing along the right-of-way lines and enforcement by the operating personnel.

Maximum grades have been limited to 3%, and this is particularly remarkable in view of the fact that the Turnpike traverses the difficult region of the Allegheny Mountains. Such a flat maximum grade has only been possible because the higher ridges of the Alleghenies have been pierced with seven tunnels, aggregating 6.7 miles in length. The width (78 ft for the graded roadway), the policy of providing as good an alinement as practicable, and the insistence on moderate grades required the excavation of 25,000,000 cu yd of earth and rock.

Any map of western Pennsylvania indicates immediately that the Alleghenies and their valleys run in a generally north and south direction, thus being squarely across and opposed to the flow of east-west traffic. Upon the completion of the Turnpike, for the first time in history motor transportation will be offered a highway through these mountains with alinement and grades that compare most favorably with those of present rural highways on the coastal plain of the eastern seaboard.

Unlike the existing highway systems of the United States, in which design standards fluctuate every few miles, depending upon the date of construction, the Turnpike will have the same design characteristics throughout its entire 160-mile length. Every effort has been directed towards securing uniform and consistent operating conditions for the motorist. In fact the design was attacked from the viewpoint of motor-car operation and the human frailty of the driver, rather than from that of the difficulty of the terrain and methods of construction. This policy of design, based on vehicle operation, is relatively new.

In order to achieve the objective of consistent operating conditions it was necessary to establish standards for the following details of design:

1. Alinement and horizontal curvature.
2. Sequence of horizontal curvature.

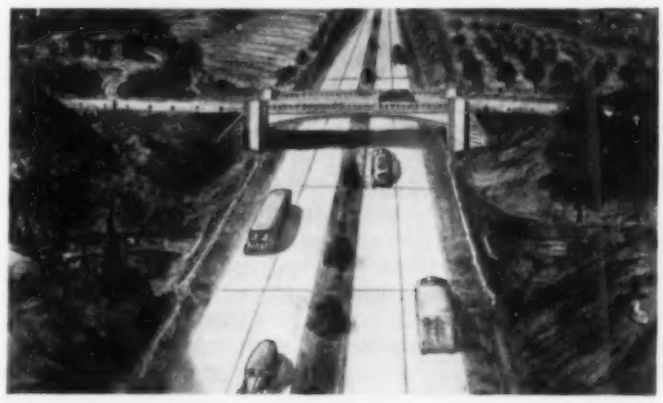

FIG. 1. CONCEPTION OF THE COMPLETED TURNPIKE, IN USE

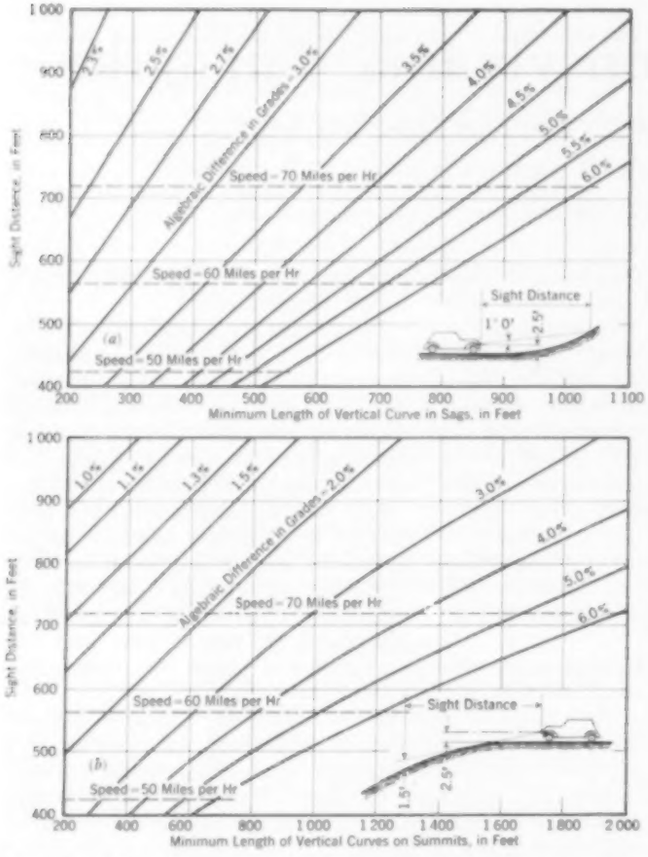
Sight Distance, in Feet
Minimum Length of Vertical Curve in Sags, in Feet
Algebraic Difference in Grades = 3.0%
Speed – 70 Miles per Hr
Speed – 60 Miles per Hr
Speed – 50 Miles per Hr
Sight Distance
(a)
Minimum Length of Vertical Curves on Summits, in Feet
Algebraic Difference in Grades = 2.0%
(b)

FIG. 2. APPLICATION OF HEAD-LAMP SIGHT DISTANCE FOR VERTICAL CURVES

(*a*) In Sags, (*b*) on Summits

3. Rear-end collision sight distance.
4. Sight distance at night with head lamps.
5. Rates of superelevation for horizontal curvature.

From the beginning a constant effort was made to improve the alinement as much as possible, consistent with the necessary economy in excavation quantities. Throughout the design period an unceasing effort was directed to reducing the degree of horizontal curvature, with the result that the 6° 00′ maximum curvature has been confined entirely to one section approximately 6 miles in length. The degree of the remaining curves has been reduced wherever possible, so that, of the 191 curves on the Turnpike, only 8 others are sharper than 4° 00′. In addition an examination was made of all sections containing tangents 6,000 ft or more in length, and the curves connecting such tangents were reduced to an absolute practicable minimum. Tangents more than three miles long are generally connected by 0° 30′ curves (radius 11,000 ft).

On the eastern end, where the topography is relatively easy, there is a 3-mile tangent and a 5½-mile tangent connected by a 0° 09′ curve (radius 38,000 ft) two miles long; also a 5½-mile tangent and a 12-mile tangent connected by a 0° 15′ curve (radius 23,000 ft). Such flat curvature is felt to be justified where the Turnpike traverses sections with fairly easy topography, and where long tangents are prevalent, because it was recognized that such conditions would induce the motorist, possibly unconsciously, to travel at relatively high speeds. The magnitude of this task of design is apparent when it is noted that 50½ miles out of the total 160-mile length are composed of curves. Spiral easements are used on all curves sharper than 2°.

It was recognized that a certain amount of hazard would be presented to the motorist if a sharp curve were introduced in a section with easy curvature on each side. Consequently all the curves on the Turnpike were examined and each group of curves was so arranged that the operating speed on adjacent curves would not, in general, vary more than 5 to 8 miles per hour (wherever topography made such a procedure possible). This refinement should eliminate the element of surprise and of failure to negotiate horizontal curves.

A straight-line diagram was utilized in studying curve reduction and curve sequence. Profiles were projected directly below the horizontal curves in order that the relation between horizontal curvature and vertical alinement might be readily visualized. Speeds corresponding to various friction factors (f) were shown, as well as the actual probable speed of the faster drivers.

Inasmuch as the traffic on each roadway will be proceeding in the same direction, sight-distance requirements were established on the basis of the distance required to bring a car to a stop in case of an obstruction on the roadway. This sight distance has been termed rear-end collision sight distance. It is the distance traveled during the perception and brake reaction period, plus that required to bring the vehicle to a stop utilizing a given value for braking friction, all computed for the specified design speed. In view of the generally high speeds expected, it was felt that stones on the pavement would give the most extreme hazard. Consequently, rear-end collision sight distance has been based on the vision from the eye of the driver to a stone or other obstruction 4 in. high. In comparison the sight distance to another car is greater than the foregoing limit on horizontal curves flatter than 3° and practically twice as great on vertical curves.

Because of the difficult terrain, the design speed adopted for rear-end collision sight distance had to be limited to 70 miles per hour, that is, where horizontal curvature would not impose an even greater limitation on speed. For 70 miles per hour the minimum rear-end collision sight distance has been determined as 600 ft. Starting with a 3° 00′ curve, this distance is progressively decreased to 475 ft for a 6° 00′ curve, the decrease being based on the lower rates of speed imposed by sharper curvature. It should be repeated that normal car-to-car sight distance is greater than these figures except on horizontal curvature sharper than 3°.

The limiting factors of horizontal and vertical curvature with respect to night visibility with head lamps have been recognized. Head-lamp visibility has been provided utilizing the same braking friction factors as for daylight visibility, but the perception and braking reaction time was increased owing to slower human reaction at night. A chart (Fig. 2*a*) was developed for providing head-lamp distance at sags in the grade line; and another (Fig. 2*b*) shows head-lamp distance at summits in the grade line. The desirable sight distance is assumed to be 1,000 ft and the minimum distances required are:

For 50 miles per hour	425 ft
For 60 miles per hour	565 ft
For 70 miles per hour	720 ft

These charts indicate the length of vertical curves required to provide head-lamp sight distance for the assumptions shown. In cases where horizontal and vertical curvature are combined, the degree of sharpness of the horizontal curve will determine the distance at which an object can be seen, because of the limited lateral spread of light from the head lamps (Fig. 3).

Because of the limitations of speed imposed by available rear-end collision sight distance due to vertical and

horizontal curvature, a careful study was made prior to establishing the rates of superelevation for horizontal curves so that traffic would not be encouraged to travel faster than required by such limitations. In other words it did not appear to be in the interest of safe operation to set up such high rates of superelevation on the flat curves that the majority of vehicles would be encouraged to travel at materially higher rates of speed than required by the limiting effect of sight distance. It was recognized that nearly all drivers develop a certain amount of unbalanced friction in driving horizontal curves, the amount of such friction depending upon the character and skill of the individual driver. Consequently, a speed diagram was prepared (Fig. 4) upon which was plotted the rate of speed for several friction factors with various rates of superelevation within the range of curvature in use on the Turnpike.

In view of the rather general agreement among highway engineers that a rate of 0.10 ft per ft of width ($1^3/_{16}$ in. per ft) is the maximum that should be used in climates where ice and snow are prevalent, this maximum was adopted. Because curvature sharper than 5° 15′ was confined to one section, as previously noted, it was decided to attain the maximum rate of $1^3/_{16}$ in. per ft on reaching the 5° 00′ curve. After considerable study the conclusion was reached that the intermediate rates of superelevation (that is, from 0 to 0.10) should be established on the basis of providing a reasonably "straight-line" speed curve for each assumed friction value. It is felt that such a procedure should enable the driver to judge rather accurately the safe operating speed by estimating the apparent sharpness of the horizontal curve.

From Fig. 4, the reasonably straight-line relation of the speed curves will be noted, as well as the very consistent operating conditions applicable on an icy surface. For design purposes the speeds used in determining spiral lengths, and daylight and head-lamp sight distances, were taken from the curve corresponding to a friction factor of $f = 0.10$, except that the tendency for "over-driving" curves sharper than 2° 45′ was recognized and provision was made therefor. The diagram shows the speed curves for several different friction values at the rates of superelevation finally adopted. It is to be noted that curves flatter than 2° 30′ permit a speed greater than 70 miles per hour at 0.10 friction. This illustrates the undesirability, from the standpoint

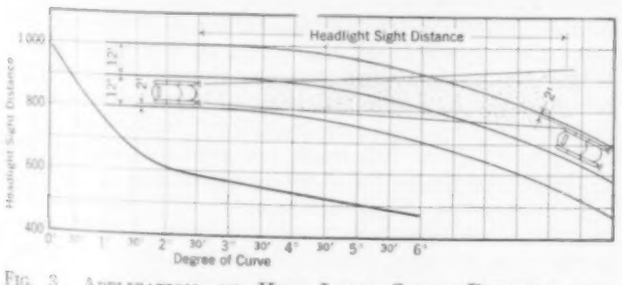

FIG. 3. APPLICATION OF HEAD-LAMP SIGHT DISTANCE FOR HORIZONTAL CURVES

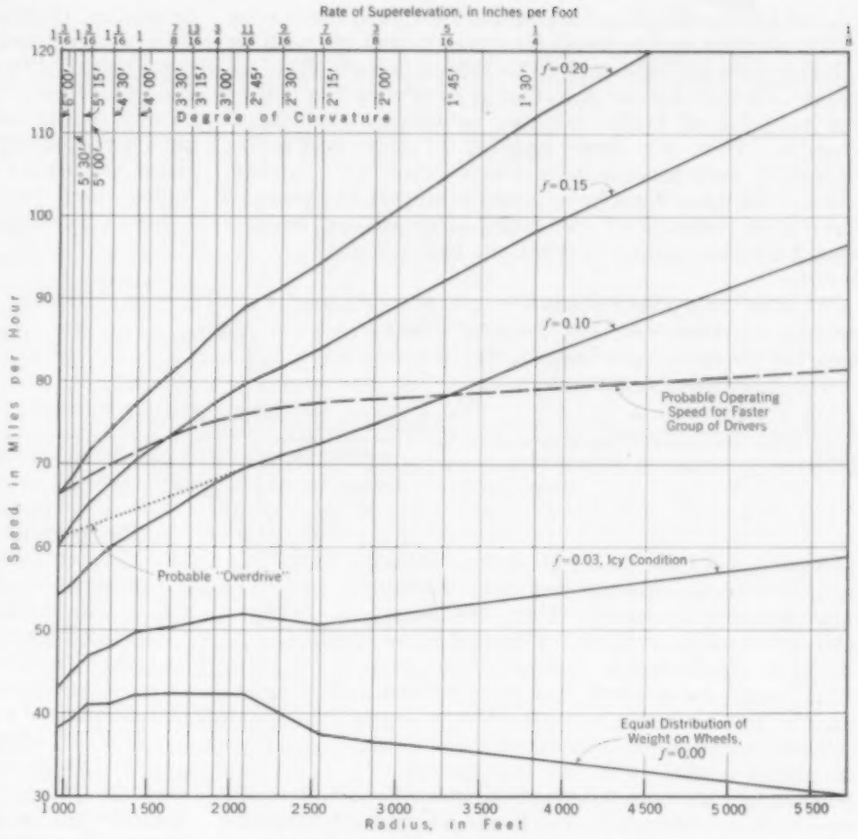

FIG. 4. SPEED DIAGRAM

of safety, of providing under these particular conditions more superelevation in curves flatter than 2° 30′ because of the limitations necessarily imposed on safe operation by sight distance.

Unfortunately, there are no official tests on the available amount of friction provided between tires and road surface before skidding occurs at speeds much in excess of 60 miles per hour, but tests made at Iowa State College by R. A. Moyer, M. Am. Soc. C.E., indicated that at around 50 miles per hour smooth wet concrete surfaces provide an ultimate coefficient of friction of approximately 0.5, or 5 times greater than that utilized in the design. High speed tends to give the driver the feeling that the car is "light on its feet"; this phenomenon should induce him to keep the speed down on curves.

Because no one to the writer's knowledge has attempted to make observations on the behavior of drivers, and the amount of friction the majority of them are willing to utilize on horizontal curves at high speed, it is not possible to predict what speeds actually will be obtained on the Turnpike. It is interesting to speculate, however, on what these speeds may be. Disregarding the 1% "speed demon" group, and considering the next 10% group of fast drivers, the situation may be somewhat as shown on the diagram labeled "Probable Operating Speed for Faster Groups of Drivers." It will be noted that this probable speed is in excess of 70 miles per hour for all curves flatter than 4° 30′, which further illustrates the fact that the speed possibilities provided by the adopted rates of superelevation are materially greater than could be met by sight distance requirements within available funds.

Access to the Turnpike is being provided at the termini (Irwin on the Pittsburgh end, Middlesex on the Harrisburg end) and at nine intermediate points, varying from 8 to 35 miles apart. Except at the termini, where

the toll booths are placed across the Turnpike, the booths will be located on the access road which connects with an adjoining feeder highway. The design is such that one booth attended by one man during each shift can collect the tolls for all traffic entering or leaving that interchange. Thus only three men per 24 hours will be required at each intermediate access point, and furthermore, vehicles will not be required to stop at any point in the entire distance of 160 miles after having reached the Turnpike proper, except at the terminal booths.

At practically every site it has been possible to arrange the grades so that the interchange is located at the center of a long sag in the grade line and so that at least 600 ft of pavement will be visible to the motorist before he reaches any deceleration lane. Thus the interchange should be visible far enough in advance to eliminate the element of surprise that would be present if it were located on the top of a rise instead of in a sag. This feature also will permit the motorist to obtain a bird's-eye view of the layout so that he can more readily distinguish the point of exit and plan accordingly. The grade adjustment necessary to accomplish this purpose extends for a distance of nearly a mile at each interchange site.

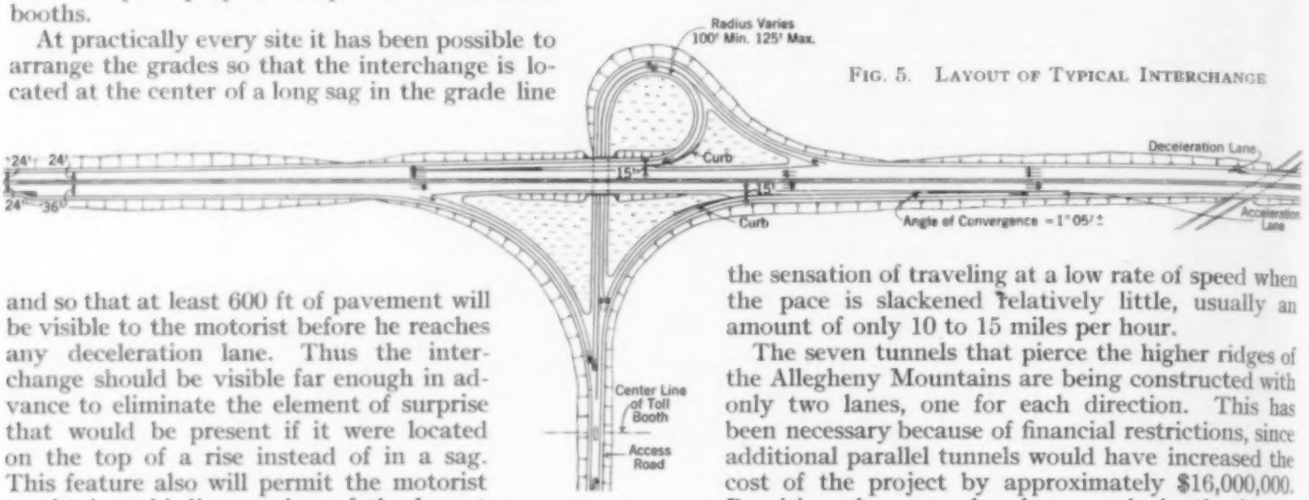

FIG. 5. LAYOUT OF TYPICAL INTERCHANGE

Acceleration and deceleration lanes are provided (Fig. 5). Deceleration lanes, 1,200 ft in length, should permit adequate slowing down by engine compression alone. The deceleration lane starts abruptly without transition because it was felt that during periods of poor visibility, such abruptness would more positively indicate the presence of the lane and the imminent approach to an interchange. The acceleration lanes, 1,200 ft in length, have been designed so as to approach the normal Turnpike roadway with such a slight angle that cars on the Turnpike can be seen in the rear-view mirror of an entering vehicle.

Such entering vehicles are confined to the curved access lane by a curb until the lane has straightened out, thus eliminating the temptation to cut directly out into the Turnpike from the curved ramp. This curbing is kept clear of the normal 10-ft Turnpike shoulder, usually a distance of 15 ft from edge of pavement. At the end of the curved ramp the elevation of the acceleration lane and that of the Turnpike are at the same grade, and therefore the entering vehicle is in plain view of vehicles traveling on the Turnpike for a period of several seconds.

Returning to the off-bound side, the peculiar shape of the turnout ramp (Fig. 5) will be noted. Such ramps have been designed in an effort to overcome an observed fault in current design. Almost invariably the motorist arrives at the point of turnout at a higher rate of speed than is safe to make the turn; this problem was given considerable study and analysis in an effort to provide a design as ideally suited to vehicle operation as possible.

As to details of the turnout, the design was based on the possibility of the motorist entering at a speed of 56 miles per hour, and then allowing him time and space to decelerate to 20 miles per hour as required by the 100-ft radius of the "loop." In arriving at the shape of the turnout, the factors assumed were brake reaction time, braking friction amounting to $f = 0.20$, and unbalanced centrifugal friction amounting to $f = 0.20$. The application of these factors resulted in a curve closely simulating a spiral; but for simplicity in field layout a series of compound curves were utilized which conformed very closely to the locus of a true spiral. It was felt that such a treatment, allowing for a high initial speed at the point of turnout, was imperative owing to the psychological fact that motorists after having driven over considerable distances at high speed, very generally have the sensation of traveling at a low rate of speed when the pace is slackened relatively little, usually an amount of only 10 to 15 miles per hour.

The seven tunnels that pierce the higher ridges of the Allegheny Mountains are being constructed with only two lanes, one for each direction. This has been necessary because of financial restrictions, since additional parallel tunnels would have increased the cost of the project by approximately $16,000,000. Provision, however, has been made in the layout and design of the present tunnels so that such parallel tunnels can be driven in the future, if and when it is financially possible.

Because of the two-way operation in the tunnels and the necessity for narrowing down from the normal Turnpike width to a tunnel roadway width of 23 ft, with two $11\frac{1}{2}$-ft lanes, very careful studies were made to provide a layout which would assure as far as possible that the traffic entering the tunnel would safely merge from two lanes into one. It was considered fundamental that such merging should take place on tangent alinement in every case where it was physically and financially possible. Consequently, at considerable extra expense, tangents were projected out from the side of the mountain at all except three of the 14 approaches. The minimum tangent was set at 800 ft, with a desirable minimum of 1,000 ft.

Near the tunnel portal curbing has been used in the center to definitely outline the roadway, and to the right of inbound traffic a wall with a stepped face has been extended out from the edge of the portal, curving away from the roadway into the cut slope. Between the wall and the roadway a low curb and sidewalk furnish a certain amount of elbow room for vehicles that may be in difficulty. The stepped wall was provided so that, in the event of mishap and collision, the accident would be confined to a sliding type where damage to the vehicle would be minimized by the stepped arrangement. The wall also forms a continuous surface so that no vehicle can collide head-on with the side of the tunnel portal. Where the roadway first narrows down on the inbound side, the shoulder is paved with a bituminous surface so that vehicles will feel free to pull out onto it, in case of emergency. Two full lanes are provided immediately at the tunnel portal for outbound traffic.

In closing it is to be emphasized that the fundamentals of safe vehicle operation have been utilized in the design of the Pennsylvania Turnpike, and in spite of an almost impossible time schedule a tremendous amount of study has been devoted to special features and details of design.

Pollution Abatement in New York Area—Westchester and Long Island

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Topography and character of soil are major influences upon the development of sewerage in an urban area. The counties of Westchester and Nassau, bordering New York City on the north and east, respectively, well illustrate by their contrasts the influences of a rough rocky terrain and a flat porous plain upon the disposal of sewage. Westchester and Nassau are swiftly growing areas whose centers of population are moving outward from the city and away from easy access to large bodies of water. Both have made considerable progress in solving their disposal problems. This paper was one of a series presented before the Sanitary Engineering Division at the Society's Annual Meeting in January.

Westchester County, with a population of 600,000, extends 30 miles along the Hudson River and 11 miles along Long Island Sound. Communities along the river and Sound early developed sewer systems discharging without treatment to the nearest waterfront. Soon municipalities on the Sound, such as Mt. Vernon and Pelham, provided sewage treatment for the prevention of local nuisances. Inland communities such as White Plains were confronted with a far more difficult problem.

Since the Bronx River and other streams of Westchester are small, and the relatively thin soil covering over a rough, rocky surface is not suited to private disposal, sewers were necessarily constructed in business and densely populated residential areas. The resulting discharge into the Bronx River in the case of White Plains caused an offensive nuisance in the valley below. A pioneer undertaking, the Bronx Valley Sewer (Fig. 1), planned and built in the interval from 1904 to 1911 at a cost of $3,000,000, was unique in two respects: it served a number of municipalities contained within its district; and the trunk sewer, instead of following the Bronx River through the Bronx to an outlet on Long Island Sound, turned abruptly west at Mt. Vernon and went through a tunnel under the intervening ridges to discharge into the Hudson River at the south edge of Yonkers (at Plant 7 in Fig. 1).

There followed a period during which inland and south-shore communities were compelled to provide sewerage and sewage treatment. For the inland areas, costly secondary treatment was necessary because of the lack of diluting water. The rapid increase of population in these sewered areas, the overloading of plants, and the inadequacy of treatment and of pumping stations, in some instances endangering the safety of public water supplies, lead inevitably to cooperative measures for solving the sewerage problem on a comprehensive drainage area basis, without regard to local political boundaries.

In June 1926, the Westchester County Sanitary Sewer Commission was established. It proceeded to develop a plan for constructing a system of trunk sewers to meet immediate and future needs for a period of fifty years, and to concentrate sewage at a minimum number of points most favorable for treatment and discharge into diluting water.

Originally the Bronx Valley sewer discharged without treatment into the Hudson at South Yonkers, and it was proposed to concentrate sewage from an immediate additional population of 80,000 people at this point. While practically no sewage entering the lower Hudson was being treated in 1929, the New York State Department of Health was determined that a start should be made as a part of this new project and that such treatment should accomplish a substantial removal of solids. On the other hand Westchester residents, concerned with the cost of primary treatment, saw no need of the county's initiating treatment in advance of New York City.

The proposal advanced by the County Commission was to use fine screens of the revolving, inclined-plane type in combination with chlorination, the screenings to be incinerated. It was argued that this type of plant could be fully enclosed. On the theory that half a loaf is better than none, the State Health Department aquiesced, with the stipulation, however, that area be shown on the plans as obtainable and capable of development for primary treatment purposes, and, further, that additional works should be constructed upon order.

An important feature of the South Yonkers plant (Plant 7, Fig. 1) was the construction of an outfall removing the point of discharge from the shore line to the trough of the Hudson River. This and the subsequent building of an intercepting sewer along the shore immediately to the north, were responsible for the principal improvement in sewage disposal in this section, the solids being transferred from the shore to deep water.

Similar fine-screen treatment was provided at Rye, at Mamaroneck, and at Central Yonkers (Plants 2, 3, and 8, Fig. 1), the latter receiving the sewage of the 26-mile Saw Mill Valley trunk and of the shore-line trunk extending north into Hastings and Dobbs Ferry. These four plants serve over 90 miles of trunk sewers.

Fine screens generally remove from 5 to 15% of the suspended solids and by retaining coarser floating solids, eliminate pollution that is obvious to the general public. However, they must be considered as the minimum of treatment, to be used only where the oxygen content of the receiving waters is not a critical factor. As to the efficiency of these plants, no information concerning the percentage removal of suspended solids has been made available. In fact, two very finely equipped chemical and bacteriological laboratories, one at Mamaroneck and the other at Central Yonkers, have remained unused for the past six years, during which time much needed and valuable information concerning character of sewage, functioning of plants, and effects of these concentrated discharges into the Hudson River and Long Island Sound might have been accumulated to the benefit of Westchester County and the whole cause of pollution abatement.

The cost of these highly mechanized plants plus the submarine outfalls (the Mamaroneck outfall being 54 in.

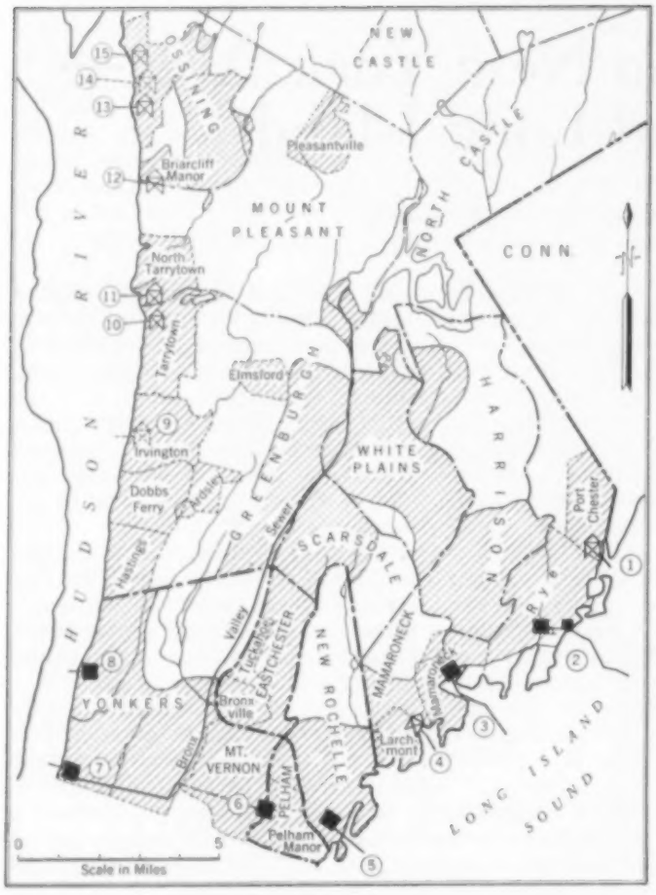


FIG. 1. SOUTHERN PART OF WESTCHESTER COUNTY, N.Y.
Sewer Districts Shown Hatched; Remainder Unsewered. Numbers Refer to Treatment Plants

in diameter and 2.42 miles long) have approached the cost of primary treatment by settling, which would have effected a four or five times greater removal of organic matter. However, conditions in Long Island Sound have apparently been satisfactory, particularly with respect to freedom of beaches from visible sewage pollution and reduction of B.coli content of bathing waters well under accepted standards. This latter improvement has been due to effective chlorination not only at the two county plants but also at the five local plants during each summer season. A survey made during the 1939 chlorination period indicated that these waters, long condemned for the taking of shellfish, are in satisfactory condition for such purposes. However, shellfish taking occurs in large part during the remainder of the year and it is doubtful whether bacteriological conditions would be found generally acceptable without year-round chlorine disinfection.

Time and natural purification factors make pollution from the upper Hudson of negligible concern to Westchester communities, but local pollution remains in the vicinity of its discharge for a considerable period and is distributed generally throughout the water on bathing beaches such as those at Crugers, Croton Point, and Kingsland Point. Moreover, the penetration of salt water to the northern boundary of Westchester is an indication of the distribution of pollution from upper New York City and Yonkers along the Westchester shore.

In 1933, the concentration of B.coli had become so great on the Hudson beaches that the Westchester County Department of Health was confronted with the necessity either of closing the beaches or of making the municipalities reduce bacterial contamination. Accordingly, orders were issued upon Tarrytown, North Tarrytown, Briarcliff Manor, Ossining, and Croton (Plants 10, 11, 12, and so on, Fig. 1) requiring the disinfection by chlorine of all sewage discharges of 100,000 gal or more per day and threatening otherwise to close the county beaches. A municipal park beach at Irvington was closed; and the opening of the Kingsland Point beach was delayed until village officials were convinced that sewage chlorination was the lesser of two evils. Finally 14 chlorinating stations were in operation on the Hudson, including the two county plants (Nos. 7 and 8) in Yonkers. In spite of the limitations inherent in an attempt to disinfect raw sewage with only such contact as could be obtained in existing short outfalls, the B.coli content of the bathing waters was found to be reduced approximately one dilution in terms of the presumptive test. While this gratifying result was only from a temporary emergency form of treatment, it did serve to introduce the idea of sewage purification to villages which for a century had run sewage down the hillside without a thought as to its destructive effect upon the beautiful Hudson.

Subsequently the situation was greatly clarified when the Interstate Sanitation Commission in 1938 gave these waters an "A" classification, thereby imposing the higher standards of the treaty compact with respect to removal of suspended solids, reduction of B.coli, and maintenance of dissolved oxygen content. In 1936 the New York State Department of Health notified all Hudson River municipalities discharging untreated sewage that adequate purification must be provided by 1940. This objective, supported by the Interstate Sanitation Commission and the Westchester County Department of Health, has had responsible local cooperation with the result that two plants at Ossining and one at North Tarrytown (Nos. 13, 15, and 11) have been started, while plants for treatment works are in varying stages in Irvington (No. 9), Tarrytown (No. 10), and, further north, at Croton and Peekskill.

These plants provide plain settling and seasonal disinfection as a minimum and are designed to meet the requirements of the interstate compact. Apparently the authorities are postponing the requirement that the two fine-screen plants at Yonkers conform to the compact until effective treatment shall be generally established above and below Yonkers.

Progress thus far warrants the anticipation of a nearly 100% treatment in some degree for the 45,000,000 gal of sewage daily discharged by Westchester County into the Hudson. It is safe to predict an early restoration of this majestic river to a condition inviting waterside

MAMARONECK PROJECT TREATMENT PLANT, ON MAIN BUSINESS STREET, HARMONIZES WITH ITS NEIGHBORHOOD
Service to 26-Sq Mile Area Has Been Notably Free from Nuisance

recreational parks, boating basins and boating, bathing beaches and bathing, and fishing.

The more spectacular aspects of community sewage disposal generally obscure the humbler problems of private sewage disposal. In Westchester many residential areas have been developed in advance of construction of sewers or where sewerage is not yet feasible. The soil has a variable but low absorption capacity and the topography is rough and rocky. Private constructors are unacquainted with the technical aspects of sewage treatment, and under the stress of competition build inadequate or faulty systems which may endanger private water supplies and which sooner than later fail, with the consequent creation of public nuisances, frequently requiring intervention of the local health authority and always thrusting a burden of cost upon the property owner.

In 1938 the county sanitary code was amended to require a permit for every private sewage disposal system constructed in the health district. Since each installation is an individual engineering problem, an application must be submitted and a permit secured in advance, based on detailed information as to soil conditions, volume of sewage, capacity and arrangement of facilities. Upon completion, the system must receive an engineering inspection. In 1939 approximately 530 such permits were issued, thus assuring to a considerable community of property owners workable sewage disposal facilities, largely protecting the surface water supplies and forestalling the eventual occurrence of a number of sewage overflows.

THE LONG ISLAND AREA

Sewage disposal in that portion of Long Island composed of Nassau and Suffolk Counties has been profoundly affected by the sandy character of the soil and its remarkable capacity for absorption. Rainfall passes to ground water with a minimum of surface runoff; there are practically no rivers; and public and private water supplies are readily obtained from wells. Nassau County, with an area of 274 sq miles bordering the Borough of Queens and extending from Long Island Sound on the north to the Atlantic Ocean on the south, has experienced a tremendous growth of population, believed now to exceed 450,000 and expected to reach one million by 1960.

It is being rapidly converted from farm land and country estates to residential areas, with ready access to beaches one of its attractive features. Conservation of these waters for bathing has always been a matter of concern but has been less impelling than their more tangible use for shellfish culture. This industry has long been important to Long Island and sufficiently a part of its economic life to make its communities sensitive to the damaging effects of sewage pollution.

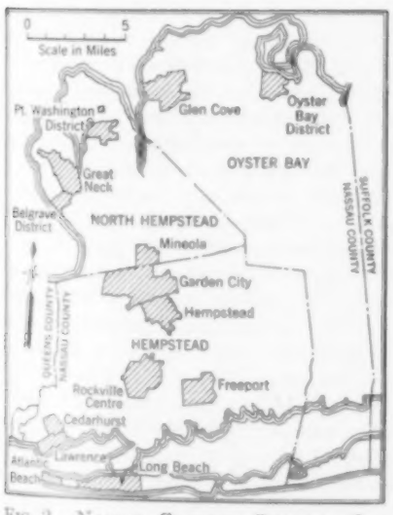
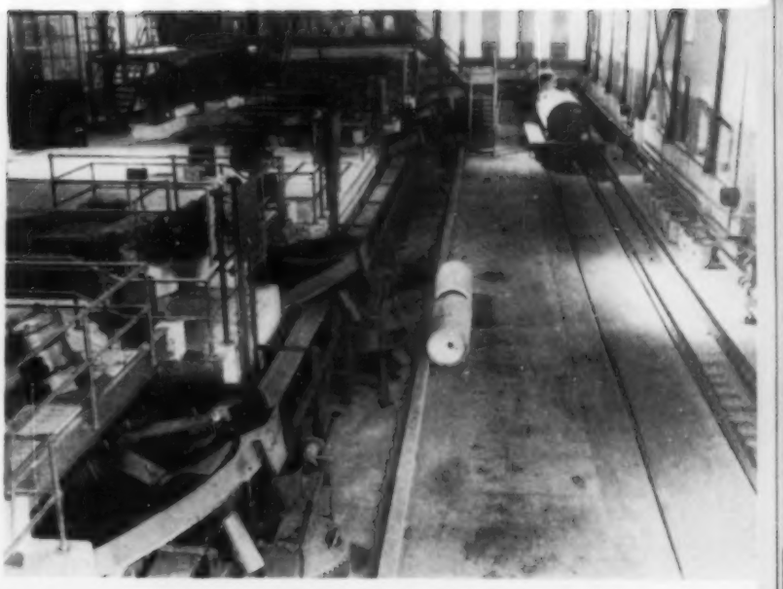


FIG. 2. NASSAU COUNTY, SHOWING LOCALITIES WITH SANITARY IMPROVEMENTS



INTERIOR OF SOUTH YONKERS PLANT, WITH SCREENS, BRUSHES, AND CONVEYO
Chlorine Cars at Right

Construction of sewers, however, has been a step reluctantly taken where private disposal into sand has been easy and long practiced. Only where high groundwater has limited absorption or where population has reached a high density have sewers been constructed. Sewage treatment has generally accompanied sewerage, the last municipal discharge of raw sewage having been eliminated in 1935. Inland villages such as Rockville Center, Hempstead, Garden City, and Mineola, being without ready access to tidal water, developed sewerage systems and a degree of treatment sufficient to permit direct return of effluent to the ground water at the plant sites.

The most remarkable fact about the disposal of sewage in Nassau County is that roughly only 25% of the population is now served by municipal systems and 75% is therefore dependent on private disposal. This unsewered population includes villages having over 15,000 inhabitants. Practical limits of population density are difficult to establish for such an area but an average of 5 per acre (3,200 per sq mile) may be considered reasonable where soil is exceptionally favorable for private sewage disposal. Business and apartment zones in these communities present the most critical conditions, wherein additional building is almost impossible, maintenance costs on private disposal facilities have become prohibitive, and real estate values are seriously depressed.

When it became obvious that a large number of villages could hardly attempt to develop separate disposal facilities, the county in 1934 secured legislative authorization for preparing a comprehensive plan of trunk sewers and treatment works. As a result it was proposed that 14 trunk sewer districts be established as needed, to cover 44% of the area of the county, 78.3% of its assessed valuation, and 95% of its population, and designed for a forty-year period. This plan, subsequently adopted, contemplates construction by a county agency with costs charged to the district served, and with lateral sewer systems constructed by municipalities or sewer districts within the trunk district. The plants proposed are of the chemical precipitation type, supplemented with some form of secondary treatment and with chlorine disinfection; and are so located as to discharge with short outfalls directly into tidewater.

Although many areas are in a desperate plight with regard to sewerage, being unable to proceed with construction of local sewers until the county program shall have gotten under way, it has been deemed expedient by the county government to postpone the start of this

Service to 26-Sq Mile Area Has Been Notably Free from Nuisance

program, estimated to cost over $13,000,000, pending the completion of a re-assessment of all property in the county and some change for the better in the burden of relief costs. An understanding between the County Executive and the State Commissioner of Health stipulates 1943 as the date when the trunk and plant in District No. 2 shall be in operation, which will receive the sewage from Mineola, Garden City, Hempstead, and Rockville Center, all of which communities previously had developed disposal by means of ground absorption.

TREATMENT PLANT FOR GREAT NECK, N.Y., SEWER DISTRICT, ON NORTH SHORE OF LONG ISLAND, NASSAU COUNTY

When over 300,000 people, as in Nassau, are dependent on private sewage-disposal facilities, there must be from 80,000 to 100,000 cesspools and leaching pools. These have been constructed over twenty years or more by persons largely without technical knowledge and with little appreciation of the relationships between volume of sewage, soil characteristics, and absorption capacities. Moreover, these builders operated without supervision or inspection and without the guidance of any specific regulations. As a result cesspools are faulty in design, inadequate in capacity, poor in construction, and occasionally located without regard to the safety of private water supplies.

Upon the establishment in 1938 of a county health department replacing 68 separate local health jurisdictions, this problem of private sewage disposal was found to require immediate engineering attention. To deal with the considerable number of sewage overflows occurring daily, a regulation was enacted prohibiting such discharges either on the surface of the ground or into water courses or tidal waters. This regulation became the basis for action to abate stream and shore pollution. Recommendations were formulated for the design and construction of cesspools, leaching pools, septic tanks, and subsurface absorption. In cooperation with the Federal Housing Administration these recommendations were made requirements for those properties on which loans were insured, so that during 1939, there were issued 1,702 certificates of inspection by the County Health Department.

The requirements applied to private residential sewage disposal are briefly as follows:

1. Estimated volume of sewage from dwellings is based on 75 gal per person per day and two persons for each bedroom, with a minimum of 300 gal.
2. Cesspools, being units in which both settling and absorption occur, are designed for an absorption rate of 2 gal per day per sq ft of effective side-wall area in ordinary clean sand.
3. Leaching pools, receiving settled sewage, may be designed for a rate of 4 gal per sq ft.
4. Cesspools and leaching pools are not approved where the normal ground-water table is within 10 ft of the surface.
5. Where ground water is within 10 ft of the surface, settling tanks having a capacity of at least one day's flow shall be used with absorption trenches designed for a rate not to exceed 3 gal per day per sq ft of bottom trench area in ordinary clean sand.

Construction and maintenance costs of private sewage disposal are rather hard to determine, but certainly several million dollars are invested in such facilities in Nassau, this outlay having a comparatively short life. Probably 10% of these systems fail or require maintenance annually and some undergo regular pumping and cleaning at short intervals where ground area is limited or absorption is exhausted. Such maintenance probably costs $200,000 per year in addition to replacement. Forty scavenger concerns operating under county health department permits dispose of about 25,000 gal of cesspool cleanings daily, using methods prescribed by the health department.

There is considerable importance in the fact that the sewage from over 350,000 people is now being returned to the ground water, thus helping to conserve a resource tremendously vital to the future development of Nassau County and Long Island. Upon the construction of the trunk sewer system, increasing volumes of ground water will be discharged to the ocean, with the probability that a point will be reached in population growth and diversion of ground water at which a large-scale recharging of treated sewage will become necessary. Artificial recharge of storm water is already being practiced in accordance with an established county policy.

From the standpoint of the Interstate Sanitation Commission, Nassau County and that portion of Suffolk County included in the treaty area present few serious problems. Principal violations of the compact standards exist at Port Jefferson and at Long Beach, the latter city having a special problem caused by an increase of population from 6,000 in winter to 75,000 in summer. Glen Cove has just completed the conversion of two old circular Imhoff tanks to plain settling tanks and has added separate sludge digestion. All sewage is subjected to year-round chlorination except at Long Beach where facilities are inadequate, and at Port Jefferson where there are none.

Pollution of tidal waters by private sewage discharges is nevertheless extensive. Hence the State Conservation Department has prohibited the taking of shellfish on inner areas of the south shore bays and the deeply indented harbors of the north shore. These discharges are small but numerous, and occur where proper private disposal appears to be difficult. Many are well concealed. As an example, waters of King Point have long been polluted by the sewage of New York City; but with the Wards Island and Tallmans Island plants in operation, it was natural to expect some lessening of the B.coli content. Investigations, however, revealed that gross pollution persisted and led to a survey which showed that forty large estates on each side of the public beach were discharging either raw sewage or septic-tank effluent directly into the sound. Since such immediate contamination is obviously more dangerous than that from the large but more distant New York City sewers, steps have been taken to abate such discharges.

Abatement of pollution so extensive and complex as that existing in the waters of the metropolitan area must necessarily be slow, but the decade just passed has certainly witnessed not only the peak of the pollutional load upon these waters but also an aggressive and widespread start upon a program of sewage purification. The enlightened policies prevailing in the major political subdivisions of the area have been expressed both in the construction of treatment works and in the establishment of the Interstate Sanitation Commission to coordinate such activities and maintain a common objective through the standards of the interstate treaty compact.

A Dynamic Model of Tacoma Narrows Bridge

By F. B. FARQUHARSON

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BECAUSE of its unprecedentedly high ratio of span to width, the Tacoma Narrows suspension bridge presented novel problems to its designers. Its lateral flexibility involved the possibility of a 20-ft deflection under wind. In order to study this and other dynamic effects, an elaborate 50-ft model—probably the first of its kind—was built at the University of Washington. The proper elastic and weight values were ingeniously devised. Of particular interest is the detailed provision of 100 horizontal electro-magnets and their controls for the purpose of simulating various forms and amounts of lateral wind force.

DURING the last decade startling developments in the art of suspension bridge design have pushed the frontiers of achievement far beyond the dreams of yesterday. Three trends are notable in modern design—a growing ratio of span length to width, an increasing sag ratio, and an ever-decreasing rigidity in the stiffening trusses. Indeed it becomes more and more apparent that the longitudinal structure supporting the roadway might more appropriately be called a distributing truss or girder. The net result of these three trends represents a steady shifting of working steel from the truss to the cable.

Prior to the building of the Golden Gate Bridge, a ratio of span to width of 40 was considered daring. In that structure it jumped to 48, and in the Tacoma Narrows Bridge it has reached 72. As might well be expected, such a drastic change has introduced complications that render prediction exceedingly precarious and necessitate greatly extended theoretical investigations.

A static model is well-nigh indispensable in two phases of the evolution of a bridge—the preliminary design and the erection. Such a model presents a relatively simple problem of construction and operation and amply justifies the expenditure of time and money. Its cost should not exceed $0.50 per ft of prototype, even if built on the large linear scale of 100 to 1. One of its principal advantages is for investigating a large number of erection possibilities that would never be attempted if each new distribution of load required the usual tedious calculations. A computation that would require from one to two days of effort by two men can be duplicated on the model in ten minutes.

Many pioneering advances have been incorporated in the design of the Tacoma Narrows Bridge. The structure itself was described in the May issue. So great is its ratio of span to width and sag that information on vibration or undulation under action of wind and traffic gathered from previous structures may be of little worth. With this thought in mind two types of model were constructed. The first was of the conventional static type employing a single cable on which all the preliminary erection studies were made. This was followed by a full dynamic model as here described.

Two distinct problems are faced in the construction of a dynamic model—constructing the model itself and providing a means of actuating it. These will be discussed separately since they are independent.

As is well known, the first of these problems would be greatly simplified if it were possible to use a material of the same elastic properties as steel and with a weight ratio equal to the scale of the model. That is, with a linear scale of 100 to 1 as adopted on this model, such material would be 100 times as heavy as steel. Its unavailability necessitates a compromise, whereby the various parts of the model are caused to duplicate the elastic properties of the corresponding parts of the prototype, after which correcting weights are added.

Up to this point the static and the dynamic model may be identical. But whereas on the static model the correction can be hung on the suspender cables as one weight, dynamic similarity requires that the weight be added symmetrically along the axis of the member itself.

A static model has a single cable with suspenders supporting one-half of the stiffening truss, roadway, and live load, all hung from towers of half the stiffness of the actual tower. It seems to be impossible to convert this simple model into a true dynamic equivalent of the prototype. Thus the first requirement of dynamic similarity is a model of the full bridge. Its fundamental requirements may be summed up as:

1. The component parts are the main cables, the towers, the suspenders, and the stiffening truss.
2. Each of these components must simulate the elastic and dynamic condition of the corresponding part of the prototype.
3. If each component part satisfies these requirements, the combination of the several parts will result in a complete model which is in all respects the dynamic equivalent of the prototype. It is assumed that the interaction between these several parts must correspond to that of the prototype. A slight difficulty arises at this point in that some of these connections involve friction, the value of which is indeterminate and possibly highly variable. These effects are of small magnitude compared with other forces on the structure and may be safely handled on the model by reducing all frictions to the lowest possible amount.

As to the main cable, it was found that the force scale used on the original static model produced moment-of-inertia requirements for the stiffening truss which rendered model duplication impossible with the materials at hand. A certain amount of cut-and-try calculation indicated that the force scale would have to be decreased from 58,279 to 45,066. This called for a music wire of

GENERAL VIEW OF MODEL

CLOSE-UP OF MODEL, SHOWING WEIGHT ADJUSTMENTS AND LATERAL DEFLECTION MECHANISM

0.071-in. diameter. Now, although this music wire was elastically correct, it weighed only approximately $^1/_{100}$ of the required amount. Dynamic similarity required that this deficiency of weight be corrected through weights added directly to the cable. Thus small weights formed of 0.72-in. diameter steel tubing filled with lead were threaded on the cable. The holes in these weights were counter-bored from each side so that each weight bore on the cable only over about $^1/_8$ in., insuring that the weights would not add to the cable stiffness. The weight added to the cable varied from bay to bay in accordance with variation in cable length. These weights were proportioned to an accuracy of ± 0.1 gram, and as an additional precaution against false stiffening of the cable, small spacing washers were mounted between them. As a result, this cable has proper elastic action, its total weight is to scale, and its dynamic behavior corresponds to that of the prototype.

At first the model towers presented a major difficulty because their dynamic behavior is impossible of calculation with any degree of accuracy. It was eventually decided that model towers of proper stiffness, and incorporating a vibration period proportional to the prototype, would satisfy the requirements. Calculations had already been made for the required stiffness of the static towers. These calculations involved only a knowledge of the longitudinal force required at the top of the prototype towers to cause a deflection of 1 in. For the full tower of the dynamic model this was multiplied by two.

Since one of the towers was nearing completion in the field, it was realized that the exact vibration period could be secured. Close cooperation with the Coast and Geodetic Survey provided the services of Dr. Dean S. Carder and a field seismograph. As the result of several days of observations, it was found that the vibration period at the west tower in a longitudinal direction was 5 sec while transversely it was 1.3 sec. Additional observations on the east tower, on which the field riveting had not been started, indicated that the riveting had no important effect on the period. Because of the considerable difference between transverse and longitudinal stiffness and period, it was assumed that the transverse characteristic could be neglected inasmuch as the stiffness in that direction on the model could be made very great, and any small action would have a negligible effect on the longitudinal behavior of the model.

For the model towers, 2-in. heavy wall steel tubing was used, mounted in ball bearing trunnions at the level of the base. A system of supported cantilever springs, as shown at *Y* in Fig. 1, was adjusted to develop the proper stiffness. Preliminary calculations gave the proportions of these springs in relation to the mass of the tower tubing with an accuracy that required only a small adjustment of a sliding weight on the tower and slight manipulation of the support under the cantilever spring. Dynamic similarity requires a period on the model varying as the square root of the scale ratio, in this case $^1/_{10}$ that of the prototype, or 0.5 sec.

Elastic equivalence was provided in the suspenders through the use of a 0.008-in. diameter music wire, and the weight was corrected by the addition of a proper number of split lead shot, each weighing approximately 1.75 grams (Figs. 1 and 2). The spacing of these weights was sufficiently close to provide dynamic similarity in each suspender.

In the design of the model stiffening truss, the assumption of interaction between truss and roadway used in the design of the prototype was followed and equivalent moments of inertia were calculated. After a study of many materials and shapes, $^7/_{16}$ brass tubing (*E*) combined with a red cedar spacer (*F*) was adopted (Fig. 2).

An experimental section of the model truss was constructed and tested as a simple beam in both horizontal and vertical planes. Since the brass-tube characteristics were not exactly right, it was necessary to drill vertical holes (*G*) in both tubes and ream them experimentally until the correct stiffnesses about both axes were developed. This procedure resulted in a structure that was elastically correct but greatly deficient in weight. It became necessary now to devise a means of adding this weight without adding to the stiffness of the truss, as shown in Figs. 1 and 2, while at the same time providing means of attaching the suspenders and applying the wind load. The base that carries the wind load magnets *A* and the magnets themselves should not be confused

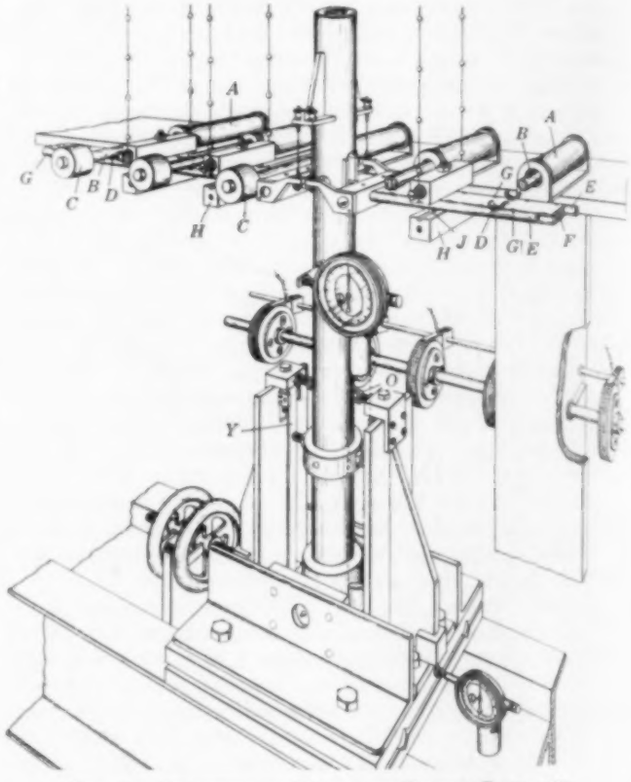

FIG. 1. DRAWING OF MODEL OF TOWER BASE AND ASSEMBLY OF PARTS

with the truss. The truss weight is made up of the members *B*, *C*, *D*, *E*, *F*, *H*, and *J*, the members *E* and *F* alone contributing to the elastic similarity.

Elastic and dynamic similarity having been achieved in each of the major component parts of the model, it was assumed that their combination would yield a complete model duplicating the dynamic action of the prototype with a high degree of fidelity. It is contemplated that a final check on the accuracy of this last assumption will be obtained on the completed structure by again employing the field seismograph.

It was recognized from the beginning that the problem was only partially solved with the construction of a model satisfying the requirements of dynamic similarity. The model must now be loaded. The effect of moving live loads had never been a matter of concern but the possible effect of wind action under various conditions offered intriguing possibilities for conjecture. It is true that the effect of the unprecedentedly high ratio of span length to width was in part offset by an unusually high sag ratio. But the net result of transferring working steel from stiffening truss to main cables produced a combination hitherto not studied on an actual structure.

The simplest lateral loading is that arising from a wind blowing horizontally and normal to the span. Standard assumptions had already been incorporated in the design calculations; hence the panel point loadings on the model were proportioned to those used in the prototype design.

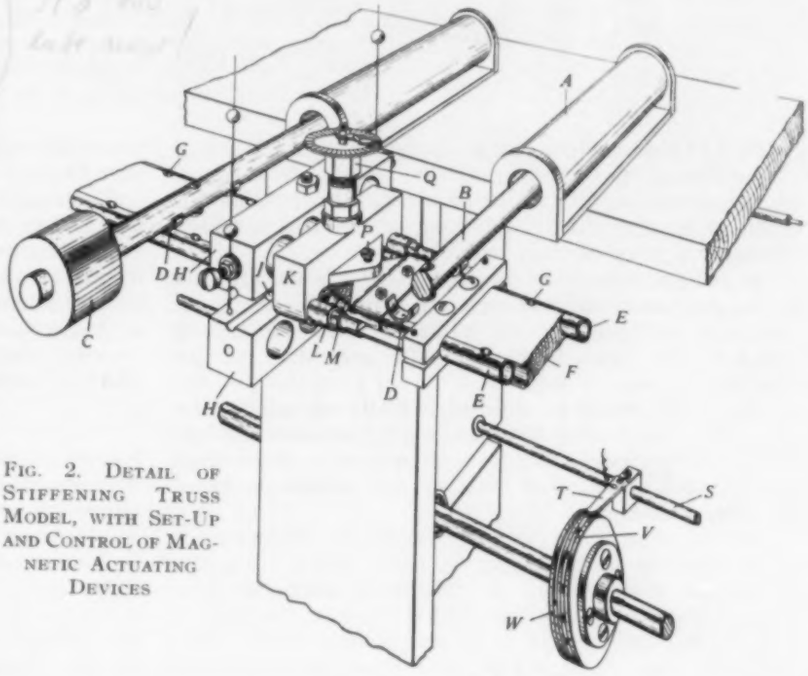

FIG. 2. DETAIL OF STIFFENING TRUSS MODEL, WITH SET-UP AND CONTROL OF MAGNETIC ACTUATING DEVICES

Studies to date have been limited to normal wind action. It is possible, however, that the most serious condition arises from the longitudinal component of a wind blowing at an angle to the span. No simple device has yet been conceived for giving this effect but an investigation is proceeding based on applying transverse and longitudinal components separately.

Of a number of suitable devices, it was decided that a combination of 100 electro-magnets and rotary switches, one for each panel point, would provide the cheapest and most flexible lateral load. A solenoid was developed with a plunger capable of a 3-in. movement and a substantially constant pull. Design calculation on the prototype had indicated that a maximum horizontal deflection at mid span of 2.4 in. could be expected on the model.

Complete lack of information regarding the action of wind on such a structure left the field wide open. The electrical system would permit a force of any intensity (up to that equivalent to a wind of 100 mph) to be applied at the panel points; and the switching system would permit the application of these loads to the model in any order and at any rate that might be conceived as logical. The order was controlled by the commutator disks while the rate was entirely a matter of the orientation of these disks and the rate at which the switch was rotated. One form of loading involves the progressive cutting in of each solenoid starting at one end. This in effect corresponds to a wind of any given intensity impinging on the structure at one end and moving progressively onto it at any desired rate.

Just as the loading covers the structure, the contactors are shifted to the second set of commutator disks, thus setting in motion a traveling wave. This loading consists of a wave front covering 6 panels or 300 ft, then a gap of 110 ft, followed by another wave of 300 ft. As in the first case, the intensity of wind action and the rate of wave travel can be controlled within wide limits.

In Fig. 2, *S* represents the contactor shaft, *T* a contactor, *W* the commutator disk for the first type of load, and *V* the commutator disk for the wave front. In practice it is found that a wide variety of vibration conditions can be developed with this second type of loading by leaving the intensity fixed at some value and varying the rate at which the wave front crosses the structure.

The motion of the model under various types of loading is recorded on moving strips of paper by a stylus pencil attached to the stiffening truss. These records are taken at the mid points of each side span and at the quarter points and mid point of the main span. In order to permit further experimental study of the action of the stiffening truss, the main-span truss has been cut at the quarter and mid points and a device inserted that will permit the absorption of a variable amount of energy at each of these points. In Fig. 2 this device is marked *K;* it consists of a piston, *M*, acting in a cylinder, *L*, and connected through the needle valve *Q* to a similar dashpot on the other side of the truss. As the truss flexes in a horizontal plane about the vertical pin *P*, one piston forces oil through the needle valve into the opposite cylinder. The energy absorbed in this operation is controlled by the setting of the needle valve. Through the manipulation of this device it is possible to vary the stiffness at these points from a free pin condition to one of the full stiffness of the truss. Further investigation will reveal the effect of thus absorbing energy on the rate at which vibration is damped out.

The construction of this model was carried out in the structural research laboratory of the civil engineering department at the University of Washington. The majority of the labor was provided by the Works Projects Administration, and the remainder of the cost was borne by the Washington Toll Bridge Authority. The writer desires to acknowledge the assistance of Lacey V. Murrow, director of highways, Charles E. Andrew, principal consulting engineer, and Clark H. Eldridge, bridge engineer for the Toll Bridge Authority, all members of the Society.

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

A Tool for Leveling

By T. A. Ross, M. Am. Soc. C.E.
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A SIMPLE tool which can be applied to many leveling problems, particularly those arising from constricted space or difficulties of sighting, consists of a length, or lengths of rubber tubing, in each end of which is inserted a piece of glass tube.

The rubber tube may be from 10 to 50 ft in total length, in convenient sections. A bore of $^3/_8$ to $^1/_2$ in. is suitable, and the glass tubes may be 9 to 12 in. long with a $^3/_{16}$ to $^1/_4$-in. bore. A boiler gage tube is very suitable.

Filled with water to a level halfway up each glass tube, this instrument forms a ready means of determining comparative levels to an accuracy depending, as ever, upon the skill of the user, but which can be of the order of 0.05 in.

Two operators are usually necessary, although it can be used in short lengths by one. After filling the instrument with water, as described, each operator places a finger over the open end to prevent the water's being spilled as the tool is moved about. Held vertically, one glass tube is placed so that the water level showing in it is in definite relation to a known or predetermined elevation, bench mark, or surface. It will follow that the water level then showing in the other glass tube is in the same relation, and vertical measurements may be made above or below it. That is the thing in essential form. Refinements or additions, such as stopcocks to replace fingers, scales against the glass tubes, and small filling-funnels at their ends, attaching-hooks, and so forth, will readily occur to every practical engineer according to the nature of his needs. (See Fig. 1.)

The knack of using it successfully will be learned with one or two trials, and needs no elaboration here. The writer has used it in many awkward holes and corners in tunnels, excavations, dugouts, and buildings, and among trees, scrub, and large boulders, where corresponding instrument work would have been tedious and costly.

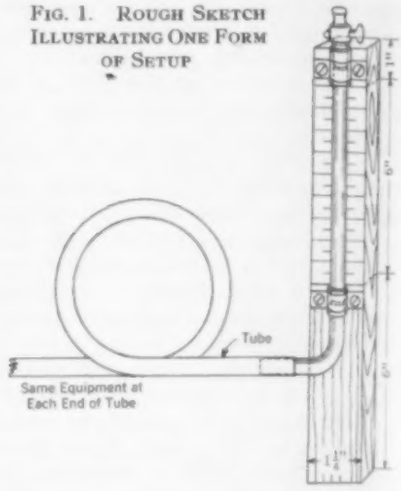


Fig. 1. Rough Sketch Illustrating One Form of Setup

As an example, it is considered that its use might replace special constructions such as the "bluffometer" referred to in the article, "Unusual Topographic Survey," by James S. Anderson in Civil Engineering for October 1939. Carried in a small, cheap suitcase along with a pint water can with a spout and one or two spare glass tubes, it forms an inexpensive, robust piece of practical field equipment.

On the Characteristics of the Huggenberger Strain Gage

By T. R. Cuykendall *and* George Winter
Respectively Assistant Professor and Research Associate, School of Civil Engineering, Cornell University

THE purpose of this article is to emphasize certain characteristics and methods of use of the widely known and highly useful Huggenberger strain gage. The operation of these gages has been described by several investigators, notably R. W. Vose (*Proceedings*, American Society for Testing Materials, Vol. 34 (1934), page 863) and Beggs and Timby (*Engineering News-Record*, March 10 and 17, 1938). However, in the extensive use of these gages we have found them to have characteristics not sufficiently described heretofore, which if not given consideration will lead to errors of considerable magnitude. These troublesome characteristics and the methods that we have employed to overcome their effects are here discussed in detail.

Two types of gages have been used: (1) Type *B* is a nickel-plated gage with 1-in. gage length, with unbalanced needle, a simple dial without mirror, and with a magnification of about 1,000. One dial division corresponds to a unit strain of about $^1/_{10,000}$ and readings can be estimated to $^1/_{10}$ of a dial division. (2) Type *F* is a black-coated gage with $^1/_2$-in. gage length, with balanced needle and a dial furnished with a mirror. The magnification is about 2,000. One dial division again corresponds to a unit strain of about $^1/_{10,000}$, and readings can be estimated to $^1/_{20}$ of a dial division. (The letters designating the gage types conform with those used in the manufacturer's catalogue.)

Two methods of calibration were used: (*a*) tension tests on a 1 by $^1/_2$-in. steel bar, the Young's modulus of which was previously determined, and (*b*) the use of a specially designed interferometer by which the wave length of the green mercury line (5,461 Angstrom units) was used as the standard of length. This instrument was designed so as to allow calibration of the tensometer in any of 4 positions. The data concerning the lag in the instrument (obviously due to friction and inaccurate

fitting of the fulcrums) were determined by means of method (*a*), while the final calibration as well as the influence of the position of the instrument on the calibration constant was obtained by method (*b*).

LAG IN THE GAGE

Other writers have mentioned the existence of a lag in the readings of the instrument with respect to actual motion of the knife edges, but have not given any numerical values of the size of this lag. In the process of calibrating a number of instruments we found irregularities which made necessary a determination of the lag, and a study of methods for its elimination.

The lag resulted in a hysteresis-like loop in the load-strain curve. Two characteristic loops are shown in Fig. 1, one for each type of gage. The effect of this lag is (1) that readings taken with increasing load do not coincide with readings taken while unloading, and (2) that at the lower end of the increasing load branch and on the upper end of the decreasing load branch there is no linear relationship between the actual strains and the gage readings. It may be noted that identical loops were obtained for repeated loading cycles—that is, readings at corresponding loads exactly coincided on the respective branches. Table I gives representative quantitative values of this lag. as observed in six instruments each of Type *B* and Type *F*. In this table "amount of lag," as expressed in unit strain and in stress for steel, represents the difference between the two parallel

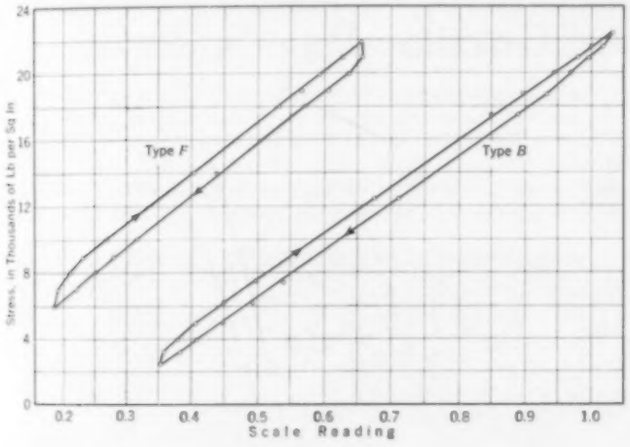


FIG. 1. TYPICAL STRESS–SCALE-READING CURVE FOR HUGGENBERGER STRAIN GAGES

straight lines of the loop; "interval of lag," expressed in the same units, represents the length of the curved parts of the loop—that is, of those parts where there is no linearity and no exact correspondence between actual strain and gage reading.

The lag is thus seen to be of practical importance.

TABLE I. LAG IN HUGGENBERGER STRAIN GAGES

Gage Type	Amount of Lag in		Interval of Lag in	
	Unit Strain	Stress in Steel per Sq. In.	Unit Strain	Stress in Steel per Sq. In.
B	2.5 to 4.5 × 10^{-4}	700 to 1,200	1.0 to 1.4 × 10^{-4}	3,000 to 4,000
F	2.5 to 4.5 × 10^{-4}	700 to 1,200	0.6 to 0.9 × 10^{-4}	2,000 to 3,000

Attempts made to reduce the size of the lag by judicious tapping of the gage and specimen were entirely futile; almost any reading could be obtained thereby.

We have employed the following methods in order to eliminate the influence of this lag: (1) In cases where comparatively large strains are measured, it is possible

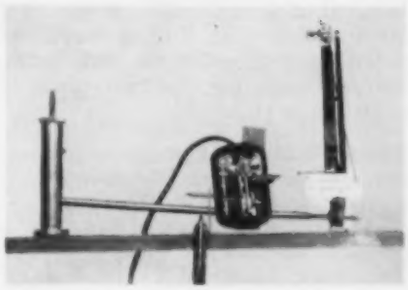
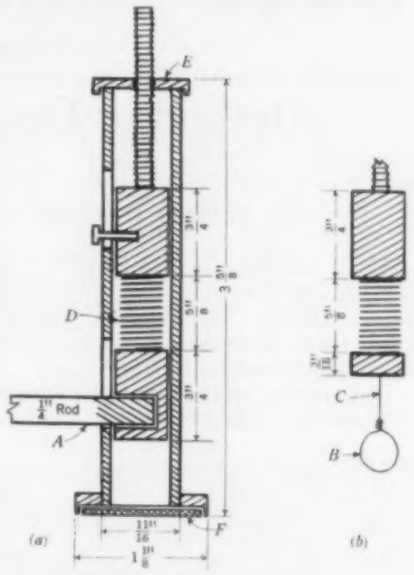


FIG. 2 A MOUNTED GAGE
At Left Is Mounting Rod Support Shown in Detail in Fig. 3. Near Middle of Rod Is Clamped Doorbell Buzzer Used to Produce High-Frequency Vibrations

to start with actual gage readings after the gage has been given an initial travel large enough to overcome the curved part of the diagram; that is, after mounting the gages, the specimen is given an initial load sufficient to produce a strain equal to or greater than the "interval of lag." In this case the instrument has passed its lag travel before actual readings are taken and the readings obtained at loads higher than this initial load will fall on the straight-line part of the diagram and hence will give reliable results. This simple method, however, is not applicable in cases where small total strains are to be measured. This is almost always the case in investigations where strain rosette measurements in three or more directions are taken, since at least one of these directions is likely to coincide with a direction of very small strain, which cannot be increased by taking a larger load increment without destroying the specimen. (2) In those cases where, for this reason, method (1) fails, it is advisable to apply high-frequency vibrations to the gage. This has been done by fixing doorbell buzzers, contacts shorted out, to the mounting rods of the gages (see Fig. 2). An auto-transformer permits variation of the intensity of vibration. The most effective intensity was found to be such that vibration of the needle is barely perceptible. Such vibration practically eliminates the lag. The Type *F* gages are more reliable in this respect than the Type *B* gages, in which sometimes a very small lag was observed despite the vibration.



A. End of Rod
B. Rigid Ring in Which End of Rod Rests
C. No. 3 American or Brown and Sharpe Piano Wire Support
D. Spring for Applying Mounting Pressure
E. Knurled Nut
F. Rubber Pad

FIG. 3. CROSS SECTION OF END-SUPPORT OF STRAIN-GAGE MOUNTING DEVICE
(*a*) As Used on Rigid Specimens; and (*b*) Wire Suspension as Used on Light-Gage Material

VARIATION OF CONSTANTS WITH MOUNTING POSITION

The calibration constants given by the manufacturer should be regarded only as grand averages, and for exact investigations should be checked by special calibration methods, the use of an interferometer being the most advisable.

The gages were calibrated in three different positions—erect, inverted, and horizontal (that is, the gage mounted on a vertical surface with the gage length horizontal). Typical values of the constants for the two types of instruments are given in Table II.

TABLE II. TYPICAL VALUES OF CONSTANTS

GAGE TYPE	ERECT	INVERTED	HORIZONTAL
B	1,060	1,090	1,010
F	2,025	2,020	1,902

Furthermore it was observed that the Type *B* gages work unsatisfactorily in a horizontal position, possibly because the needles are not balanced on this type. Their use in this position should be avoided if possible.

MOUNTING DEVICE

Corresponding to the observations of Vose, it was found that no rigid mounting device should be used, the springiness of the mounting being a condition essential to the proper working of the gages.

Beggs has described a mounting satisfying this essential condition (loc. cit.). This device consists of a flexible steel rod attached through rubber links to the strain gage at one end and clamped to the specimen at the middle and at the other end. The mounting pressure is applied by the rigidity of the mounting rod itself. We found, however, that the adjustment and control of the mounting pressure necessary in connection with the vibration method discussed above could not be achieved with the simply clamped rod as described by Beggs.

Therefore we now employ a much heavier rod and the mounting pressure is applied to the rod by a calibrated coil spring in the end support of the rod (end opposite to gage, see Figs. 2, 3*a*). After the rod is in place in the mount, the knurled nut *E*, Fig. 3*a*, is turned until a mounting pressure of about 16 lb is obtained. Too low pressures easily cause slip if vibration is used, while higher pressures may damage the instrument.

In bending tests on light gage material it was found that the deformation of the part of the specimen between the gage and the end support may be of sufficient magnitude to produce a considerable motion of the rod with respect to its initial position. This motion, by putting more pressure on one foot than the other, by tipping, or in some other way, changes the proper mounting of the gage and hence leads to erroneous strain measurements. This difficulty has been corrected by suspending the rod from a steel wire fastened to the base of the coil spring in the support. (See Fig. 3*b*.) In this way the rod is given two degrees of freedom, perpendicular and parallel to itself, which prevents the motion of the supports from being transmitted to the rod and thus to the gage. This mounting has proved entirely satisfactory in tests on material down to 22 gage.

Method of Determining Lip of Circular Pipe Spillway

By PAUL J. CANNELL, M. AM. SOC. C.E.

HYDRAULIC ENGINEER AND CHIEF DESIGNER, CENTRAL NEBRASKA PUBLIC POWER AND IRRIGATION DISTRICT, HASTINGS, NEBR.

THE following is a description of a method of determining the curve for a circular or "morning-glory" type spillway. I have used this method, and a test of the model spillway laid out in this manner shows it to be sufficiently exact.

In making up the points for the curve, the curve should always be pushed slightly toward the center of the spillway to lessen chances of negative pressure on the lip. To further lessen this chance the lip of the spillway may be vented by air.

In the sketch shown (Fig. 1) the average velocity was taken as occurring at the center line of the stream, but the same method may be used assuming this velocity at some other point. The difference between using the center line of the stream and using one-third of the depth is not great. The error in this method lies in neglect of friction but the friction is not a very large factor.

Given: Spillway crest level, reservoir level, and Q for which spillway is to be designed.

Solution: Determine length of weir from these factors, as for a straight weir, and make this the circumference of the spillway at the crest. If there are any piers along the crest, add the pier widths and the contraction at the piers to this length. Call the radius at the crest R_1 (see Fig. 1). Next, lay out the upper and lower nappe of a free falling stream. The coordinates for these curves have been obtained from Bazin's experiments and are printed in Creager and Justin's *Hydroelectric Handbook*, page 209. From this plot the center line of this free falling stream. Determine the velocity, V_1, at the crest. This may be done by scaling the depth D_1, multiplying D_1 by the length of the crest, and dividing Q by the product. The velocity head at the crest is, of course, $H_1 = V_1^2/2g$. Lay out line *A* a distance H_1 above the center line of the stream. As the stream of water goes into the circular spillway, it will have to be

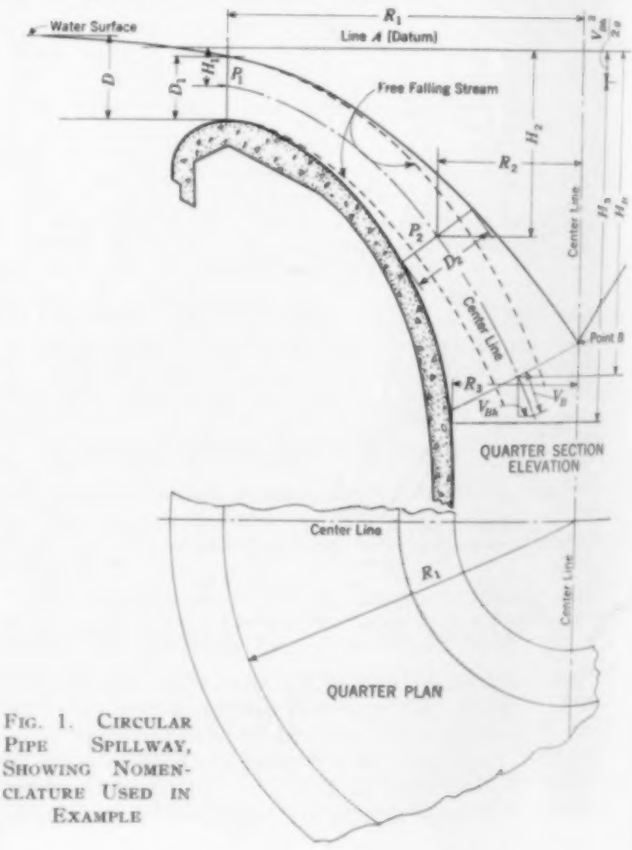


FIG. 1. CIRCULAR PIPE SPILLWAY, SHOWING NOMENCLATURE USED IN EXAMPLE

deeper than if it went over a straight spillway, because the length (circumference) of the spillway decreases as the water approaches the center. To determine how much the stream depth is increased at any point, say, P_2, scale the depth H_2 from A to point P_2, and calculate the velocity from the formula $V_2 = \sqrt{2gH_2}$. Calculate the "width" of the stress at this point by measuring R_2. Knowing V_2, Q, and the "width" of the stream, it is easy to calculate the depth, D_2, the only other unknown. This enables one to plot both the upper and lower nappe of the stream going over a circular weir.

Beginning with the point B, where the upper nappe intersects the center line, a different procedure must be followed. From here down, the diameter of the spillway must be sufficient to take the quantity of water at the velocity that can be obtained in a free fall from a line located a distance $V_{Bh}^2/2g$ below line A. V_{Bh} can readily be obtained by scaling H_B, calculating V_B, and then obtaining the horizontal component V_{Bh} graphically. (We are assuming that all the head from this velocity V_{Bh} is lost in the collision with the stream from the opposite side.) Lay off a new datum line $V_{Bh}^2/2g$ below line A. After scaling H_3, R can be readily determined from the formula, $R_3 = \sqrt{\dfrac{Q}{\pi\sqrt{2gH_3}}}$

(This follows from the relations $V_3 = \sqrt{2gH_3}$, $A_3 =$ cross-sectional area $= Q/V_3$, and $R_3 = \sqrt{A_3/\pi}$.)

Point B is not fixed and it will be necessary to smooth out and make tangent the upper and lower curves where they join. In a model test the mushroom of frothy water in the center of the spillway rose and fell 6 to 8 in., in a model 30 in. in outside diameter and 9 in. in diameter at its lowest point, and with a flow of about 5 cu ft per sec, although Q was presumably constant. This would seem to indicate that great care in obtaining the exact quantities involved is not necessary, but a model test to determine points of possible negative head in a spillway frequently used is very desirable.

For a further and more general solution see "The Hydraulic Design of the Shaft Spillway for the Davis Bridge Dam," by Ford Kurtz (TRANSACTIONS, Vol. 88, 1925, page 1).

Our Readers Say—

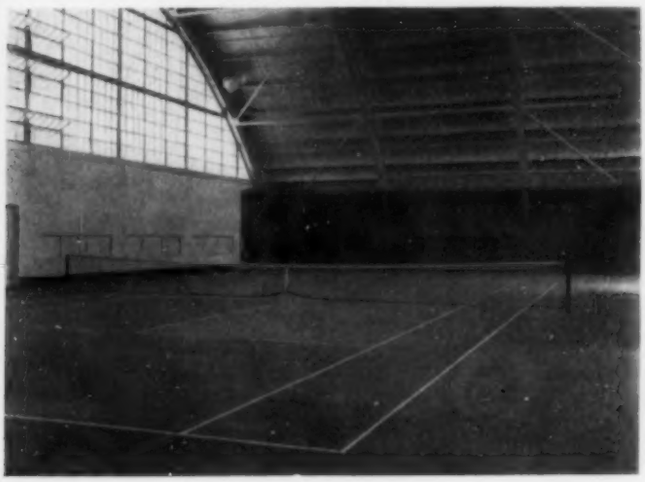
In Comment on Papers, Society Affairs, and Related Professional Interests

Simplicity in Structural Design

TO THE EDITOR: One of the advantages of simplicity in structural design, comparatively rare perhaps, yet sometimes important, is the avoidance of interference with special purposes for which certain structures are to be used. Many gymnasia and other buildings, for instance, are erected for the primary purpose of playing games indoors; in nearly every one of these games a ball (or a puck or a "bird") is an important implement of play, and where the structural steel frame of the building is exposed (as it frequently is under the roof), it often becomes important to make this frame as simple as possible, in order to present a non-confusing background against which the ball may be seen clearly, and to avoid "ball traps" in which the ball may be imprisoned beyond the convenient reach of the players. Plate girders are often the answer.

A number of buildings for play have been designed in my office, and where feasible, plate girders have been used as the main roof members. Leading examples are indoor tennis court buildings of the "trajectory" type, in which the principal structural members are arch ribs completely exposed inside under the roof. These ribs have been built up of angles bent, and plates cut, each to the required curve, but in one interesting case the simplicity was carried

(1) ARCH RIB LYING ON FLOOR OF SHOP JUST AFTER BENDING



(2) INTERIOR VIEW OF FINISHED BUILDING SHOWING BENT I-BEAMS AS ARCH RIBS

still further and a rolled I-beam was used, bent cold to the required radius. As the size of the member was 27 in., 91 lb, and the required radius of the axis was 76 ft, 3 in., I was frankly dubious when this substitution was suggested. However, the bending operation

was successfully carried out in the shops of the American Bridge Company, at a saving of $1,684, for four ribs, each about 170 ft long. (Because of variations in the bids the saving to the owner was $622.) The accompanying photograph shows part of one of the arch ribs lying flat on the floor of the shop just after bending. Particular attention is invited to the interesting stress lines in the web in the foreground, produced in the surface by the torturing of the metal during the bending operations. The scale and position of these ribs are such that the slight waviness produced in the edges of the flanges (brought out in the picture by the curved template alongside) became invisible when they were erected. This is indicated in the interior view of the finished building.

A little trick, which has become standard practice in my office in designing roofs over areas intended for playing tennis and similar games, is to reverse the channels used for purlins on the slopes, and set them with their flanges projecting downward instead of upward. Although this makes the connections slightly less efficient, it is useful in eliminating many possible ball traps. Incidentally, it may be of interest to note that it has been found useful to include in the specifications an explanation of this departure from customary standards, to forestall questions from the puzzled fabricators.

Human beings are so constituted that they particularly enjoy pleasant surroundings when indulging in relaxation and recreation. Therefore a pleasing appearance is particularly desirable in a structure used for recreation; as economy and space saving are also major considerations, we find simplicity of structural design in recreation buildings especially important for several reasons.

GAVIN HADDEN, M. Am. Soc. C.E.
Civil Engineer

New York, N.Y.

Data on Skin Friction

TO THE EDITOR: In connection with Professor Kimball's article on "Settlement Studies of Huey P. Long Bridge," in the March issue, I was especially interested in his statement that "It has been further assumed that all the load is transmitted to the soil at the bottom of the caisson seal. The load that might be permanently transmitted through skin friction along the sides of the pier has never been determined." Presumably the word "never" refers to the calculations prepared for this particular bridge design.

I would like to point out that there is available a considerable amount of practical information on skin friction in relation to bridge pier design, none of which appears to have been utilized in connection with the Huey P. Long bridge foundations. Much of this material is to be found in the record of bridge engineering in India, in which country engineers have long had to deal with foundation conditions comparable to those at the site of the bridge under review.

As indicative of Indian practice and experience, there may be mentioned the following figures given by R. Mair in his published description of the Willingdon Bridge across the river Hooghly at Calcutta (*Minutes of Proceedings*, Institution of Civil Engineers, Vol. 235, pp. 36 to 128, 1934). Summarizing recent Indian bridge design practice, Mr. Mair gives a table from which the following figures are abstracted.

BRIDGE	WILLINGDON	SARA	JUBILEE	RUPNARAYAN
Span (ft)	350	345	540	310
Pressure on bases of caissons without deductions (kips per sq ft)	25.8	29.2	20.6	17.0
Net pressure on caisson bases (kips per sq ft)	7.9	12.3	8.3	7.0
Skin friction allowed (lb per sq ft)	560	504	280	280
Nature of supporting strata	Yellow clay and sand	Compacted sand	Hard yellow clay	Sand

Mr. Mair acknowledges the difficulty of determining the true value of skin friction, but cites experiences during the construction of the Willingdon Bridge which gave actual values in the vicinity of 1,000 lb per sq ft. Other comparable figures are available, and although they cannot be used indiscriminately, their well-established use in Indian bridge practice makes Professor Kimball's quoted statement hard to appreciate.

To avoid any possibility of misunderstanding, may I make quite clear the fact that I am not contrasting the somewhat empirical data available on skin friction with the results of such exhaustive and detailed studies as were made prior to the construction of the Huey Long Bridge. I appreciate and value highly all that modern soil mechanics research can do and already has done in the important field of bridge foundation engineering. But I feel that this application of the results of soil mechanics studies to practical design work with apparent disregard for the accumulated practical experience of many preceding decades may possibly provide a clue to the discrepancies between theory and practice which Professor Kimball has described.

R. F. LEGGET, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering, University of Toronto

Toronto, Canada

Culture for the Civil Engineer

TO THE EDITOR: Many writers of late have with good reason advocated rather drastic changes in engineering curricula, even to the extent of revising secondary training in the high schools and planning courses designed for the embryo engineer. It is a well-known fact that in the foreign countries, particularly Germany, the prospective engineer begins his training during high school days. However, regardless of the reasons, American engineering is second to none and no other country can compare with us in number, size, and boldness of execution of public works. Where else but here can one find a Boulder Dam or a San Francisco–Oakland Bay Bridge?

Under our democratic system of government it is more difficult to initiate rigid training for the engineer at an early age than under a totalitarian system of government such as exists in Germany today. I firmly believe that the high school course for the engineer should be broadly cultural and should give him an opportunity to acquire a general knowledge that will fit him to embark on a college career and prepare for any of the professions.

For example, in my own case, I pursued the standard academic course in the high schools of the city of Pittsburgh. At the time of graduation, I had the proper credits to enter either a pre-law, pre-medicine, dentistry, or engineering school. And although this course provided more than enough basic knowledge in mathematics, physics, chemistry, and the other sciences, yet ample provision was made for English, Latin, Spanish, French, economics, and civics. In short, the student had sufficient general knowledge to embark upon any career.

Some engineers have advocated elimination of languages such as Latin, Spanish, and French from the high school curricula, yet at the same time deplore the lack of culture exhibited by the engineer. During my high school days not only did I find the study of Latin and Spanish of great aid in the study of the English language, but of inestimable value in stimulating the study of word forms—their derivation, their meaning, their use. Moreover, many high school students have difficulty in deciding upon the proper career to select, and in my opinion it would be unwise to eliminate courses of study that would either close the doors to certain careers or result in expending valuable time at a later date to meet the deficiency.

High school courses could be revised to the benefit of all the professions in the following manner:

1. Elect or appoint more doctors, lawyers, engineers, and other professional men to our school boards.
2. Establish an orientation course for the different professions and acquaint the student with the educational and experience requirements of the profession in question, the type of personality most likely to succeed, the working conditions, the job probabilities, and the probable earnings.

As to the engineering curricula in our accredited institutions it is felt that, considering the time available, these schools do an excellent job of training students in a technical way for the profession of engineering, and to devote more time to the so-called cultural studies would seriously deprive the student of much needed and valuable technical training.

No man can succeed in any field of work without exhibiting a keen interest in such work. And by the same token no engineer can attain culture unless he exhibits a keen interest in culture, and this interest cannot be initiated by formal training especially to the disadvantage of technical training.

If the engineering student truly desires culture let him get it on his own time during vacation periods and other free hours without sacrifice to his technical training. Let the professor and the engineer stress the value of culture in terms of success and the enjoyment of life. After all, doesn't the average engineer have the time to read and the mind to understand the classics and the other fields of endeavor?

W. S. WALKER, Assoc. M. Am. Soc. C.E.
Manager of the Transportation Division and Golden Triangle Division, Chamber of Commerce
Pittsburgh, Pa.

Cultural Subjects Desirable in Engineering Curricula

DEAR SIR: The article entitled "Training for Civil Engineering Students" by B. F. Hastings, which appeared in the May issue, is a criticism of education in general and of the specific education of those preparing to enter the profession of engineering. Mr. Hastings is not sufficiently explicit to warrant an ample discussion of his proposed curriculum, nor could he be without writing an article that would be too long for publication.

Discussion has been fairly continuous for forty years, and the critic needs, first, to study the S.P.E.E. Investigation of Engineering Education. The investigation was a very incisive and constructive analysis and synthesis such as engineers should be able to make.

Secondly it is necessary to know high school trends and present college curricula. For instance, high school graduates are not prepared to begin the study of calculus in the freshman year.

Furthermore, other considerations than preparation to enter an engineering institution are dictating the content of the average high school curriculum. The demand for vocational education is one. Economy is another. Only about 15% of high school graduates go to college. What the majority want is a major factor.

Mr. Hastings is "sympathetic to the idea that an intelligent human being should have relatively wide interests in so-called cultural subjects," but leaves these to after-graduation. His opinion is not in accord with the expressed judgment of engineers and engineering teachers. The trend has been toward introducing the student while in college to options which he may select or may be advised to take. The hope is that he may continue to explore his citizenship afterwards. Many have not.

Options are provided in the curriculum presented by Mr. Hastings, but many would conclude he was prescribing more of the same kind of narrow specialization that past curricula provided.

Many able, cultured engineers who had the urge to acquire that breadth of social understanding which is so desirable were graduated from such curricula. But many others have not had the far-sightedness and energy to thus equip themselves, and changes that have been made in engineering curricula have had them in mind.

The engineer is not only responsible for his own economic welfare, but is now being asked to help the economist and the sociologist in solving riddles that have baffled them. The engineer needs to be forwarned, and his thinking can well take in a broader territory if the profession is to be more than technically competent.

R. L. SACKETT, M. Am. Soc. C.E.
Dean Emeritus of Engineering, Pennsylvania State College
New York, N.Y.

Publicity for the Profession

DEAR SIR: The ineptness of engineers in presenting an attractive picture of their profession to the public is well known. This was impressed upon me at one of our Society's national meetings where a large number of noted technicians and administrators were present.

At that meeting the local engineers had a capable young woman as publicity manager. She was brilliant and had excellent ideas. She told me that the meeting was the toughest she had ever attempted to cover; that we had present the most prominent civil engineers in the country, but apparently they would not give anything to the reporters that was suitable for their publications, except in a few cases.

When she introduced reporters to some important engineer, the reporter would ask the engineer to tell him about the big bridge that was built over a certain river at a certain place. The engineer would reply that the bridge was not a big one, that there were many in the world that were much larger. The reporter would then suggest that there might have been some tough engineering problems that had to be handled in connection with the construction work. The engineer would remark that there were none, that the job ran along according to schedule and nothing of importance was encountered. Then the reporter would ask the engineer to tell why the bridge was built at that place at that time, and what would be the sociological, industrial, and commercial consequences of having this structure. The engineer in effect would say that this was out of his field and he was not particularly interested. The result was that the reporter got nothing.

According to that woman, if we engineers would talk to the man on the street in his language, and tell why we do our work and what would be the consequences of having done it, the profession would receive valuable publicity on the front pages of all the newspapers in the country. She remarked that there is hardly a single engineering structure erected that is not of importance to the citizens of its particular community.

This criticism strikes home to most engineers. My plea, therefore, is for a more articulate engineering attitude—not a matter of personal publicity, which usually defeats its own end, but of a favorable reaction on the public of the profession as a whole. This is a real need.

WILLIAM BOWIE, M. Am. Soc. C.E.
U. S. Coast & Geodetic Survey
Washington, D.C.

The Writing of Technical Articles

TO THE EDITOR: It is well worth while for any engineer who has an article in mind to ask himself his motive in writing. If he is enthusiastic over a subject and wishes to transmit his knowledge to others his motive is a worthy one and he should proceed. Again, his main object may be to see his name in print. Such was evidently the case with an engineer, just graduated, who asked the librarian of a technical library for a list of subjects suitable for articles. It was his intention, he explained, to write for the technical press. Such articles could not be more than compilations. In this connection let it be emphasized that there may be a wide difference between a compilation and a restatement. "Virtual Work: a Restatement" (PROCEEDINGS, Am. Soc. C.E., February 1926), by Prof. Hardy Cross, may be cited.

One could name a dozen books on the technique of composition that are more or less helpful. The writer many years ago formulated for his own guidance a few "Rules for Writing." He gave expression to them in Part II of PROCEEDINGS (March 1929). They have served their purpose so well that they are repeated here:

1. Be sure that you have something worth while to say.
2. Read what others have written on the subject.
3. Have in mind your readers—express yourself in language as simple as you would use in conversation.
4. Avoid irrelevant matter; never try to show how much you know.
5. Be generous with your credits.
6. Give special attention to the introduction and to the conclusion.
7. Bear in mind the logical presentation, sequence of sentences, and clearness. After writing, examine carefully for errors in spelling, grammar, and punctuation.
8. If time permits, lay the manuscript aside for a month; then reread and revise. Boil it down!
9. If practicable have the manuscript examined for correctness by one well acquainted with the subject and for clearness by one who has little or no knowledge of the subject.
10. Be prepared to have the manuscript returned as "not available." Better not talk much about it until it has appeared in print.

ROBINS FLEMING
Structural Engineer (Retired)
New York, N.Y.

English Important in Engineering Curricula

TO THE EDITOR: With the recent and recurrent plea for greater recognition for the achievements of engineers in mind, Mr. Hastings' "Proposed Curriculum," outlined in the May issue, seems a step in the wrong direction. The complete neglect of formal education in the art of using one's native tongue is a serious omission in any course of training. A considerable command over, and appreciation of, English as an indispensable instrument for self-expression in writing and in speech is essential for a useful professional career. The lack of competent familiarity with the English language tends to be a basic reason for engineers' failure to acquaint the lay public with engineering achievements and their economic and social significance. How else but by the art of communication can an engineer tell anyone what he has done and what it means? Or, for that matter, how can he understand his own work if he doesn't understand the meaning of the terms?

Problems in oral and written communication are just as real and numerous as the engineering problems encountered in our profession. In fact, the first problem the graduate engineer faces is one calling for important application of the art of communication—the personal interview.

Papers on research may well be studded with purely technical phraseology, but a report to a client must be couched in terms that the client can readily understand. The engineer must be able to talk the language of his audience. I recall the incident of an engineer reporting possible economies to the board of directors of his company. One of his points was the savings to be had in reducing the wattless component present in the electrical energy being purchased by the concern. The term "wattless component" was a puzzle to the members of the board. Questioned as to its meaning, the engineer gave the technical explanation but that failed to enlighten his listeners. However they did understand after he said, "Now take a full glass of beer, figuratively of course, and not full of beer, but filled partly with beer and partly with foam. The foam costs you money but it isn't any good to you. You haven't any use for it, but you get it and you have to pay for it. That foam is the beer's wattless component."

And to whom shall we leave the task of presenting understandable technical testimony in court of law if the engineer is to be, through lack of adequate training, inarticulate?

S. STARR WALBRIDGE, Assoc. M. Am. Soc. C.E.
Chief Design Engineer, W. Earle Andrews
New York, N.Y.

Direct Solution of Catenary Equations

TO THE EDITOR: On page 306 of the May number Professor Joffe has given a neat method of solving the catenary equations by successive approximations. A direct solution, however, can be obtained so easily that the process for it seems worth mentioning, because the tables of functions available for the purpose are not at all well known. Using the notation of the article, with the addition of $u = wa/2H$ and $\lambda = L - a$, the catenary equations become

$$\begin{aligned} H &= wa/2u & &= wa.A \\ b &= a\,(\cosh u - 1)/2u & &= a.B \\ T &= wa\,(\cosh u)/2u & &= wa.C \\ \lambda &= a\,(\sinh u - u)/u & &= a.D \end{aligned}$$

where A, B, C, and D are tabulated with u as argument in *Sags and Tensions in Overhead Lines* by C. G. Watson (Pitman Publishing Corporation, New York, 1931).

Using the numerical example given by Professor Joffe, $B = b/a = 0.160$, and entering the tables with this value the argument $u = 0.620$ is found; hence $H = wa/2u = 2{,}419$ lb. Entering the tables again with the same value of u, it is seen that $C = 0.9665$ so that $T = wa.C = 2{,}899$ lb. These two results of course agree with those in the example.

The same book contains similar tables for use in the more troublesome case of inclined spans.

J. B. MACPHAIL, Assoc. M. Am. Soc. C.E.
Montreal, Canada

Antique Surveying Instrument

DEAR SIR: In 1890 I was engaged in laying out one of the boom-towns—now the city of Pulaski, Va. My employer, a Danish engineer, had at first only one modern transit instrument and, in addition, an "antique." The latter instrument was made by Young and was of brass except, of course, for the silver of the limb, the dividing of which was good. So were the glasses of the telescope. The eyepiece end was short so as to pass through the standards and had a piece of sheet lead rolled to fit the inside and balance the long end.

An extension from the lower plate carried a circular bubble level which, when necessary, could be bent up or down for adjustment. The lower plate was clamped to the spindle by a milled head screw and moved by a ratchet. The movement of the plates for measurement of the angle was made by a tangent screw with milled head. Like most of the instruments in those days, this also had a 4- or 5-circular compass between the standards.

Pretty good work in laying out town lots was done with this antique, which may still be in existence—somewhere in southwest Virginia.

R. A. MACGREGOR, M. Am. Soc. C.E.
New York, N.Y.

Population Growth in the United States

TO THE EDITOR: A study of the population growth in the United States beginning with 1800 and based on the count each ten years developed some interesting facts.

The population is probably a continuous function of the time. It is practicable to determine the elements of the curve on the basis of population and time by successive differentiation and integration. The curve for the first 70 years is represented as follows: $P = 6.761 + 0.006537T^2$, where P is expressed in millions and T in years since 1800.

The growth in population during this period was comparatively uniform and the curve fits very closely to the actual count of the Census Bureau. For instance, the curve would indicate a population of 12,638,000 in 1830, whereas the census count showed 12,686,000. In 1850 the indicated population would be 23,086,000, and the count was 23,192,000. In 1870 the indicated population would be 38,758,000 and the count was 38,558,000. It is seen that this curve shows the history of the development very closely for the first 70 years. Beginning with 1870 and for the next 60 years, the formula introduces an additional factor involving the first power of the time and assumes the form $P = 0.0051T^2 + 0.383T - 12.883$.

Here again the curve represents very closely the history of the development. In 1890 the indicated population would be 62,897,000 and the count was 62,722,000; in 1910, 90,957,000 and the count 91,972,000; and in 1930, 123,097,000 and the count 122,775,000. The curve shows the actual conditions with a population variation of approximately 1%. We see the count of 1910 above the curve following a ten-year period of comparative prosperity. The count of 1920 is below the curve following a period of depression and war. The count of 1930 is still below the curve, but the rate of increase has expanded until the actual ordinate is very close to the curve. In 1940 the indicated population is 140,697,000, and the count will probably be slightly under the curve, say 140,250,000. With more settled economic conditions—similar to those in the period 1920 to 1930—during the next ten years, the count should show an expansion in the rate of increase so that it will correspond to the curve very closely and reach 159,300,000.

An interesting observation in connection with this population curve is that the great depressions of 1870 to 1880 and 1890 to 1900 appear to have had little, if any, effect on the rate of increase. Thus there are great possibilities for expansion of production and consumption in a nation whose population is increasing with the combined first and second power of the time.

G. L. BILDERBECK, M. Am. Soc. C.E.
Consulting Engineer
New London, Conn.

Seventieth Annual Convention

Denver, Colo., July 24–26, 1940

Brown Palace Hotel to Be Headquarters

Opening Session and Business Meeting

WEDNESDAY—July 24, 1940—Morning

9:00 **Registration**

9:45 **Convention called to order by**

ROY A. KLEIN, *President, Colorado Section, Am. Soc. C.E.; Senior Highway Engineer, U.S. Public Roads Administration,* Denver, Colo.

9:50 **Addresses of Welcome**

HIS EXCELLENCY RALPH L. CARR, *Governor of the State of Colorado,* Denver, Colo

HIS HONOR BENJAMIN F. STAPLETON, *Mayor of the City of Denver,* Colo.

10:15 **Response**

JOHN P. HOGAN, *President, American Society of Civil Engineers.*

10:20 **Annual Address**

JOHN P. HOGAN, *President, American Society of Civil Engineers.*

Business Meeting and Luncheon Recess

WEDNESDAY LUNCHEON FOR MEN

At the close of the Wednesday morning session, there will be a luncheon for members and men guests at the Cosmopolitan Hotel at 12:15 p.m.

COL. H. S. CROCKER, *Past-President and Honorary Member, Am. Soc. C.E.,* will address the luncheon on "The History of the Local Section."

Tickets for the luncheon are $1.25 each.

WEDNESDAY—July 24, 1940—Afternoon

SYMPOSIUM ON ACTIVITIES—BUREAU OF RECLAMATION

JOSEPH JACOBS, *Vice-President, Am. Soc. C.E., Chairman;* R. F. WALTER, *M. Am. Soc. C.E., Chief Engineer, U.S. Bureau of Reclamation, Presiding*

2:00 **The Broad View of Reclamation**

J. C. PAGE, *M. Am. Soc. C.E., Commissioner, U.S. Bureau of Reclamation,* Washington, D.C.

2:30 **Project Planning**

E. B. DEBLER, *M. Am. Soc. C.E., Hydraulic Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

3:00 **Project Construction**

S. O. HARPER, *M. Am. Soc. C.E., Assistant Chief Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

3:30 **Discussion**

MUNICIPAL BUILDING, DENVER, COLO.

WEDNESDAY—July 24, 1940—Evening

7:00 Dinner, Entertainment and Dance in the Lincoln Room of the Shirley-Savoy Hotel

An unusual entertainment has been planned that will appeal to both young and old.
Dancing following dinner and entertainment.
Tickets are $3.00 each. Tickets for Juniors, per couple, for dance only are $1.50.

SITE OF GREEN MOUNTAIN DAM, COLORADO

VASQUEZ CANAL, CARRYING WATER TO MOFFAT TUNNEL

Sessions of Technical Divisions

THURSDAY—July 25, 1940—Morning

STRUCTURAL DIVISION

9:30 New Solution of Stresses in Circular Plates

M. A. SEILER, *Assoc. M. Am. Soc. C.E., Assistant Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

10:00 Discussion opened by

F. C. CARSTARPHEN, *M. Am. Soc. C.E., Consulting Engineer,* Denver, Colo.

10:30 Earthquakes and Structures

R. E. GLOVER, *Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

11:00 Discussion opened by

HARRY A. WILLIAMS, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, Stanford University,* Stanford University, Calif.

HYDRAULICS DIVISION

FRED C. SCOBEY, *Chairman, Executive Committee, Presiding*

9:30 Conformity Between Model and Prototype of Spillway Flow Over Madden Dam

PHILIP S. SHAUGHNESSY, *Engineer, Engineering Department, Panama Canal,* Canal Zone.

10:15 Discussion opened by

RICHARD R. RANDOLPH, *Engineer, U.S. Engineer Office,* Tulsa, Okla.

10:45 The Use of Models in Designing Outlets at Dams

E. W. LANE, *M. Am. Soc. C.E., Professor, Hydraulic Engineering, Hydraulic Laboratory, University of Iowa,* Iowa City, Iowa.

11:00 The Use of Models in Designing Outlets at Dams, with Particular Reference to Grand Coulee

J. E. WARNOCK, *M. Am. Soc. C.E., Hydraulic Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

11:15 Discussion opened by

J. C. STEVENS, *M. Am. Soc. C.E., Consulting Hydraulic Engineer,* Portland, Ore.

SOIL MECHANICS AND FOUNDATIONS DIVISION

CARLTON S. PROCTOR, *Chairman, Executive Committee, Presiding*

9:30 Report of Subcommittee on Cores, Cutoffs and Impermeazation

O. N. FLOYD, *M. Am. Soc. C.E., Consulting Engineer,* Dallas, Tex., *Chairman.*

9:40 Types of Earth Dams

BENJAMIN K. HOUGH, JR., *Assoc. M. Am. Soc. C.E., Engineer, U.S. Engineer Department, Binghamton District, U.S. Engineer Office,* Ithaca, N.Y.

10:10 Discussion opened by

K. B. KEENER, *M. Am. Soc. C.E., Designing Engineer on Dams, U.S. Bureau of Reclamation,* Denver, Colo.

S. C. HOLLISTER, *M. Am. Soc. C.E., Dean, College of Engineering, Cornell University,* Ithaca, N.Y.

10:30 Current Work of the Committee on Sampling and Testing

JOEL D. JUSTIN, *M. Am. Soc. C.E., Consulting Engineer,* Philadelphia, Pa., *Chairman.*

10:35 Progress in Developing Improved Methods for Obtaining Indisturbed Samples of Soils

M. J. HVORSLEV, *Assoc. M. Am. Soc. C.E., Research Engineer, Committee on Sampling and Testing, Graduate School of Engineering, Harvard University,* Cambridge, Mass.

11:15 Discussion opened by

KARL TERZAGHI, *M. Am. Soc. C.E., Visiting Lecturer, Harvard University,* Cambridge, Mass.

T. E. STANTON, *M. Am. Soc. C.E., Materials and Research Engineer,* and O. J. PORTER, *Senior Physical Testing Engineer, State Division of Highways,* Sacramento, Calif.

K. E. FIELDS, *Jun. Am. Soc. C.E., 1st Lieutenant, Corps of Engineers, U.S.A., Director, U.S. Waterways Experiment Station,* Vicksburg, Miss.

11:30 Open discussion

SURVEYING AND MAPPING DIVISION

WILLIAM BOWIE, *Chairman, Executive Committee, Presiding*

9:30 Methods and Problems of the U.S. Cadastral Engineering Service

R. K. ALLEN, *Administrative Cadastral Engineer, U.S. Cadastral Engineering Service,* Denver, Colo.

10:15 Discussion opened by

JOHN S. KNOWLES, *Cadastral Engineer, U.S. Cadastral Engineering Service,* Denver, Colo.

10:30 The Denver Topographic Survey

FRED GRAFF, JR., *Section Chief, Rocky Mountain Section, Topographic Mapping, U.S. Geological Survey,* Denver, Colo.

11:15 Discussion opened by

M. J. GLESSNER, *Topographic Engineer, U.S. Geological Survey,* Denver, Colo.

Open House at Bureau of Reclamation

THURSDAY—July 25, 1940—Afternoon

All engineers attending the Annual Convention are cordially invited to attend the Open House of the Bureau of Reclamation in its laboratories at the Custom House.

The various engineering activities of the Bureau will be described by Bureau employees, depicted by photographic exhibits, and shown by both still and operating models. Photoelastic instruments, testing machines, shop facilities, and various laboratory demonstrations will be available for inspection. Descriptive pamphlets covering special problems will be distributed. Some of the more important exhibits tentatively planned are outlined below.

Project Investigations

Operating model of Boulder Canyon project.
Map showing location of basin and project investigations.
Large diagram showing threads of project investigation progress.
Diagrammatic sketch of Central Valley project.
Photographic panels illustrating all phases of Reclamation activities and developments.

Design and Construction

Migratory-fish control—models, diagrams, and photographs.
Construction materials—chemical and microscopic studies.
Typical cross sections of earth dams on different foundations.
Earth-dam models, material tests, pore-pressure measurements, analyses, etc.
Bridge design, featuring Pit River and Grand Coulee spillway bridges.
Model tests of a counterforted-wall face slab.
Joints in concrete construction.
Concrete investigations, triaxial loading and Mohr's criteria of failure.
Mass concrete—thermal properties, temperature control, curing, core tests, etc.
Placing concrete—vibration compaction, absorptive form lining, etc.
Improved methods of concreting around scroll cases.

Canals and Water Control

Operating model of ring-gate seal.
Methods of de-icing piers, gates, and trashracks at Grand Coulee Dam.
Operating model—automatically controlled radial gate, chute, and stilling pool.
Inverted siphon structure—models, diagrams, and photographs.
Operating model of siphon spillway.
Developments in needle-valve design.

Dams, Power Plants, Pumping Plants

Shasta Dam—operating model of dam and power plant.
Friant Dam—operating model of outlet works and stilling pool.
Grand Coulee Dam—operating model of spillway bucket.
Grand Coulee pumping plant—operating models of intake, penstock, and discharge.
Grand Coulee turbines—operating model of draft tube, intake, and runner.
Bartlett multiple-arch dam—models, cores, diagrams, and photographs.
Sectional model through outlet works at an earth dam.
Green Mountain power plant—operating model of intake and penstock design.
Operating model of pump for circulating power-plant cooling water.
Operating model of Columbia River bed through Little Dalles.
Separate spillway structures—side channel, superelevated, and tunnel types.

The Open House will start at 12:45 p.m. and will continue throughout the afternoon. Buses will operate between the headquarters hotel and the New Custom House for the convenience of members, ladies, and guests attending this function.

GARDEN OF THE GODS, COLORADO SPRINGS, COLO.

PIKE'S PEAK SEEN THROUGH GATEWAY OF GARDEN OF THE GODS

Dinner, Theater, After-Theater Entertainment at Central City

THURSDAY—July 25, 1940—Evening

6:30 Dinner at the Historic Teller House in Central City, Followed by an Evening at the Central City Opera House to See a Performance of Smetana's Comic Opera, "The Bartered Bride"

Busses will leave the Brown Palace Hotel at various times throughout the late afternoon for Central City, with the last bus leaving the hotel at 5:15 p.m.

Dinner will be served at 6:30 p.m. and the opera will follow the dinner. There will be ample time for guests to inspect the many interesting features of the hotel and theater.

Tickets for the dinner and opera, including transportation to and from Central City, are $6.50 each. Following the opera, arrangements have been made for members, ladies, and guests to attend a night club performance at the Teller House. Tickets for the after-theater entertainment are $1.00 each.

Sufficient busses will be held at Central City to take care of all those who attend the after-theater entertainment.

Sessions of Technical Divisions

FRIDAY—July 26, 1940—Morning

SOIL MECHANICS AND FOUNDATIONS DIVISION

CARLTON S. PROCTOR, *Chairman, Executive Committee, Presiding*

SYMPOSIUM

9:15 New Theories and Concepts in Analytic Soil Mechanics

J. H. A. BRAHTZ, *Director of Photoelastic Laboratory, U.S. Bureau of Reclamation*, Denver, Colo.

9:35 Discussion opened by

WILLIAM P. CREAGER, *M. Am. Soc. C.E., Consulting Engineer*, Buffalo, N.Y.

THEODOR VON KÁRMÁN, *M. Am. Soc. C.E., Director, Daniel Guggenheim Aeronautical Laboratories, California Institute of Technology*, Pasadena, Calif.

9:55 New Theories and Concepts in Analytic Soil Mechanics—As Applied to Earth Dams

C. N. ZANGAR, *Assistant Engineer, U.S. Bureau of Reclamation*, Denver, Colo.

10:25 Discussion opened by

PAUL F. ROSSELL, *M. Am. Soc. C.E.*, Richmond, Va.

WARREN RAEDER, *M. Am. Soc. C.E., Professor, Civil Engineering, University of Colorado*, Boulder, Colo.

10:45 Other Methods of Analytic Soil Mechanics

R. E. GLOVER and F. E. CORNWELL, *Engineers, U.S. Bureau of Reclamation*, Denver, Colo.

11:15 Discussion opened by

DONALD W. TAYLOR, *Assoc. M. Am. Soc. C.E., Assistant Professor, Soil Mechanics, Massachusetts Institute of Technology*, Cambridge, Mass.

GLENNON GILBOY, *Assoc. M. Am. Soc. C.E., Consulting Engineer*, South Lincoln, Mass.

IRRIGATION DIVISION

S. T. HARDING, *Chairman, Executive Committee, Presiding*

9:30 Multiple Use Aspects of Irrigation Projects

E. B. DEBLER, *M. Am. Soc. C.E., Hydraulic Engineer, U.S. Bureau of Reclamation*, Denver, Colo.

10:00 Discussion opened by

M. C. HINDERLIDER, *M. Am. Soc. C.E., State Engineer*, Denver, Colo.

C. I. GRIMM, *M. Am. Soc. C.E., Head Engineer, U.S. Engineer Department, North Pacific Division*, Portland, Ore.

10:30 Activities of the Mexican National Commission of Irrigation

FRANCISCO GOMEZ-PEREZ, *Assoc. M. Am. Soc. C.E., Chief, Control Division, Designing Department, National Commission of Irrigation, Government of Mexico*, Mexico, D.F., Mexico.

11:30 Discussion

HIGHWAY DIVISION

WILLIAM NELSON CAREY, *M. Am. Soc. C.E., Chairman;* CLARENCE L. ECKEL, *M. Am. Soc. C.E., Professor, Civil Engineering, and Head, Civil Engineering Department, University of Colorado*, Boulder, Colo., *Presiding*

9:30 Rational Method of Analyzing Fills

RUSSELL W. JAMES, *M. Am. Soc. C.E., Associate Highway Bridge Engineer, U.S. Public Roads Administration*, Denver, Colo.

10:30 Discussion opened by

MERLIN G. SPANGLER, *Assoc. M. Am. Soc. C.E., Research Associate Professor, Civil Engineering, Iowa Engineering Experiment Station, Iowa State College*, Ames, Iowa.

11:00 The Monarch Pass, Colorado, Highway Project

D. W. ORMSBEE, *Assoc. M. Am. Soc. C.E., Construction Engineer*, and J. S. MARSHALL, *Assoc. M. Am. Soc. C.E., Chief Draftsman, State Highway Department*, Denver, Colo.

11:45 Discussion opened by

CHARLES F. SEIFRIED, *M. Am. Soc. C.E., Chief Engineer, State Highway Department*, Cheyenne, Wyo.

OPERATING GALLERY OF MOFFAT FILTER PLANT, DENVER'S MOST MODERN WATER PURIFICATION PLANT

DENVER'S SEWAGE TREATMENT PLANT SHOWING SLUDGE TANKS AND EFFLUENT FILTER BEDS

Occupy Entire Day, Friday

FRIDAY—July 26, 1940—Afternoon

SOIL MECHANICS AND FOUNDATIONS DIVISION

CARLTON S. PROCTOR, *Chairman, Executive Committee, Presiding*

2:00 **A Study of Stability Analyses Methods—Report of Subcommittee on Structural Design of Embankments and Foundations**

T. A. MIDDLEBROOKS, *Assoc. M. Am. Soc. C.E., Senior Engineer, Chief, Soil Mechanics Section, Office, Chief of Engineers,* Washington, D.C., *Chairman.*

2:20 **Discussion opened by**

J. H. A. BRAHTZ, *Director of Photoelastic Laboratory, U.S. Bureau of Reclamation,* Denver, Colo.

2:30 **Report of Subcommittee on Consolidation of Embankment and Foundation Materials**

WILLIAM P. CREAGER, *M. Am. Soc. C.E., Consulting Engineer,* Buffalo, N.Y., *Chairman.*

3:00 **Discussion opened by**

FRANK F. SMITH, *Senior Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

W. J. TURNBULL, *Assoc. M. Am. Soc. C.E., Soils Engineer and Chief of Laboratory, The Central Nebraska Public Power and Irrigation District,* Ogallala, Nebr.

3:20 **Compaction of Cohesionless Foundation Soils by Means of Explosives**

A. K. B. LYMAN, *M. Am. Soc. C.E., Colonel, Corps of Engineers, U.S.A., 3d Engineers,* Schofield Barracks, Hawaii.

(To be presented by JAMES H. STRATTON, *Assoc. M. Am. Soc. C.E., Captain, Corps of Engineers, U.S.A., U.S. Engineer Office,* Caddoa, Colo.

4:00 **Discussion opened by**

K. E. FIELDS, *Jun. Am. Soc. C.E., 1st Lieutenant, Corps of Engineers, U.S.A., Director, U.S. Waterways Experiment Station,* Vicksburg, Miss.

BENJAMIN K. HOUGH, JR., *Assoc. M. Am. Soc. C.E., Engineer, U. S. Engineer Department, Binghamton District, U.S. Engineer Office,* Ithaca, N.Y.

IRRIGATION DIVISION

S. T. HARDING, *Chairman, Executive Committee, Presiding*

2:00 **Salts in Irrigation Water**

RAYMOND A. HILL, *M. Am. Soc. C.E., Consulting Engineer,* Los Angeles, Calif.

2:40 **Discussion opened by**

S. C. SCOFIELD, *Principal Agriculturist in Charge, Bureau of Plant Industry,* Washington, D.C.

3:10 **Consumptive Use of Water for Agriculture**

A. F. JOHNSON, *Assoc. M. Am. Soc. C.E., Associate Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

3:40 **Discussion opened by**

R. J. TIPTON, *Assoc. M. Am. Soc. C.E., Consulting Engineer,* Denver, Colo.

R. L. LOWRY, JR., *Assoc. M. Am. Soc. C.E., Engineer, National Resources Planning Board, Pecos River Joint Investigation,* Roswell, N.Mex.

HIGHWAY DIVISION

WILLIAM NELSON CAREY, *M. Am. Soc. C.E., Chairman;* RALPH D. GOODRICH, *M. Am. Soc. C.E., Dean, College of Engineering, University of Wyoming,* Laramie, Wyo., *Presiding*

2:00 **Colorado State-Wide Planning Survey**

JOHN E. FURLONG, *State Manager for State Highway Department,* Denver, Colo.

2:45 **Discussion opened by**

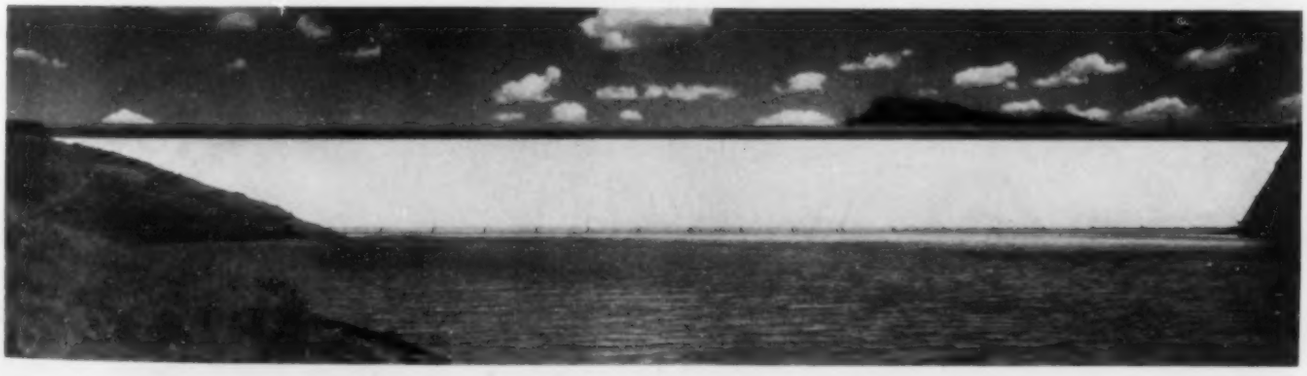
KIRK A. KEEGAN, *Statistician, National Safety Council,* Chicago, Ill.

3:15 **Developments in Bridge Engineering in the West**

MAURICE HOUSECROFT, *Assoc. M. Am. Soc. C.E., Chief Bridge Engineer, State Road Commission,* Salt Lake City, Utah.

4:00 **Discussion opened by**

JOHN G. MASON, *M. Am. Soc. C.E., Bridge Engineer, State Department of Roads and Irrigation,* Lincoln, Nebr.



CRYSTAL CREEK DAM WITH WELDED STEEL FACE—CITY OF COLORADO SPRINGS

HYDRAULICS DIVISION

FRED C. SCOBEY, *Chairman, Executive Committee, Presiding*

2:00 **Silt Problems of the Imperial Dam and the All-American Canal**

C. P. VETTER, *M. Am. Soc. C.E., Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

2:30 **Discussion opened by**

RALPH L. PARSHALL, *Assoc. M. Am. Soc. C.E., Senior Engineer, Soil Conservation Service,* Fort Collins, Colo.

3:00 **Hydraulic Phenomena in Large Penstocks with Particular Reference to Plant at Boulder Dam**

S. P. WING, *M. Am. Soc. C.E., Civil Engineer, U.S. Bureau of Reclamation,* Denver, Colo.

3:30 **Discussion opened by**

FRED C. SCOBEY, *M. Am. Soc. C.E., Associate Engineer in Charge, Pecos River Joint Investigation, National Resources Planning Board,* Roswell, N.Mex.

Entertainment for the Ladies

WEDNESDAY—July 24, 1940

Morning and Afternoon

Entertainment and Luncheon for Ladies

At the close of the Wednesday morning session of the Convention, the ladies will gather at the Brown Palace Hotel and go by automobile to the Lakewood Country Club for a reception and luncheon, followed by entertainment, returning to the hotel in the afternoon.

This luncheon and entertainment is complimentary to the visiting ladies.

Evening

Dinner and Entertainment followed by Dancing

This event will be held in the Lincoln Room of the Shirley-Savoy Hotel. An unusual entertainment has been planned that will appeal to both young and old.

Tickets for the dinner and dance are $3.00.

Juniors and their ladies who do not care to attend the dinner and entertainment will be admitted for the dancing at $1.50 per couple.

THURSDAY—July 25, 1940

Morning

Entertainment for the Ladies

A program of sketches depicting "The Glory that was Gold," descriptive of the early days in Central City, has been arranged. This entertainment will start at 10:30 a.m. and will continue for about an hour. It will be held at the Brown Palace Hotel

Tickets complimentary to all ladies.

Afternoon

Open House at the Bureau of Reclamation in the New Custom House

This should prove to be a very entertaining and instructive affair to both ladies and gentlemen.

The open house will start at 12:45 p.m. and will continue throughout the afternoon.

Busses will operate between the headquarters hotel and the New Custom House for the convenience of members, ladies, and guests attending this function.

Evening

Dinner at the Historic Teller House in Central City Followed by an Evening at the Central City Opera House Where a Performance of Smetana's Comic Opera, "The Bartered Bride," Will Be Given

Busses for this party will leave the Brown Palace Hotel at various times throughout the late afternoon for Central City, with the last bus leaving the hotel at 5:15 p.m.

Dinner will be served at 6:30 p.m. and the opera will follow the dinner.

Ample time will be given for guests to inspect the many interesting features of the hotel and theater.

Tickets for this function, including dinner, transportation to and from Central City, and the theater are $6.50 each.

After the opera a night club performance will be held at the Teller House.

Tickets for the after-theater entertainment are $1.00 each.

Enough busses will be held at Central City until after the night club performance to take care of those wishing to attend.

FRIDAY—July 26, 1940

Afternoon

Informal Tours and Tea

Informal tours to points of interest throughout the City of Denver have been arranged, with tea at the home of Mrs. Roy A. Klein, wife of the President of the Local Section.

Automobiles will leave the Brown Palace Hotel starting at 2:00 p.m.

Tickets complimentary to all ladies.

VIEW OF MOUNT MASSIVE FROM THE SIDE; SHARP PEAK AT LEFT IS MOUNT ELBERT

Excursions and Trips

ALL-DAY EXCURSION TO MT. EVANS

SATURDAY—July 27, 1940

This trip to the top of Mt. Evans, 14,260 ft, will traverse the highest automobile road in the world. The peak affords unsurpassed views of the mountains to the north, south, and west, and of the plains to the east, and the buildings in the city of Denver some 40 miles distant are readily discernible on a clear day.

Leaving Denver at 9:00 a.m., high-lights of the trip include: the drive over the Lariat Trail to the top of Lookout Mountain, visit to Buffalo Bill's grave and museum, passage through the Denver City mountain parks, Idaho Springs with its gold mines, Echo Lake nestled in the pines, Summit Lake high above timber line, and the climb to the peak.

Luncheon will be served at Echo Lake Lodge at 1:30 to 2:30 p.m.

The return trip will be through Evergreen, down Bear Creek Canyon, through the Red Rocks Park, and across the dinosaur-trodden Hog Backs, arriving in Denver about 6:00 p.m.

Tickets, including luncheon and transportation, $2.50 each.

Morning and Afternoon

Inspection and Sightseeing in Denver

Short city excursions are available on Saturday to those members and guests who do not wish to take the all-day excursion to Mt Evans. Optional points of interest are the Natural History Museum in City Park, Denver's new sewage disposal plant, and the United States Army air school.

POST-CONVENTION TRIPS

SATURDAY AND SUNDAY—July 27 and 28, 1940

Estes Park and Rocky Mountain National Park

A two-day excursion circle trip through Estes Park and Rocky Mountain National Park over Trail Ridge Road with overnight stop at Grand Lake, returning on Highway 40 over Berthoud Pass, is available at commercial excursion rates.

Arrangements will be made for anyone desiring to take this trip. Transportation by bus. Tickets, including meals, lodging, and transportation, $23.40 each.

Colorado Springs and Vicinity

An excursion is also planned for those members and guests who may wish to visit Colorado Springs and vicinity after the Convention has come to an end.

Arrangements can be made at time of registration or later whereby trains leaving Denver on Saturday morning will be met at Colorado Springs for an all-day excursion to the top of Pike's Peak and other nearby points of interest.

AIR VIEW OF DENVER—STATE CAPITOL IN RIGHT FOREGROUND AND CIVIC CENTER IN LEFT FOREGROUND

Conference of Juniors

TUESDAY—July 23, 1940

In keeping with the policy of bringing together Local Section and Student Chapter representatives to discuss the problems of these two groups, it has seemed desirable to the Juniors of the Colorado Section to have a similar conference at which representatives of Junior organizations could share experiences. It is hoped that representatives of organized groups will attend, and that Juniors from Sections which have no special Junior groups will be present to discuss the problems in those localities.

Morning

9:30 Welcome by

O. C. REEDY, *Jun. Am. Soc. C.E., Assistant Engineer, U.S. Bureau of Reclamation*, Denver, Colo.

The Needs of the Junior

Brief talks by two Juniors, followed by discussion.

The Junior Organization: (1) History, (2) Meetings, (3) Program, (4) Membership

Brief talks by representatives of Junior organizations, together with discussion.

How May Juniors Best Function When Unorganized and in Small Numbers

Brief talks by representatives of two Sections, followed by discussion.

12:15 Luncheon, Junior Representatives with Representatives of Local Sections

Price 85 cents per person.

Afternoon

2:00 Joint Meeting of Juniors with Representatives of Local Sections

It is hoped that this Conference of Juniors will assist Juniors better to serve themselves, the Society, and the profession.

Local Sections Conference

TUESDAY—July 23, 1940

Morning

J. T. L. MCNEW, *Society Committee on Local Sections, Presiding*

All interested members of the Society are invited to attend the Conference of the representatives of the Western Local Sections. The official representatives will discuss generally the following two main questions, and in detail the specific subjects listed below.

How Can Local Sections Be Made of Greatest Benefit to the Profession?

What Duties and Functions May Properly Be Turned Over to Local Sections?

9:30 A. Address of Welcome, ROY A. KLEIN, *President, Colorado Section*
B. Local Committees on Professional Objectives
C. Local Section Adminstration
D. How Can a State Council of Local Sections of the Society Be Organized and Work Effectively?

Luncheon

12:15 Joint Luncheon with Junior Representatives

Afternoon

2:00 Junior Representatives Join the Conference
E. Local Section Opportunities, JOHN P. HOGAN, *President, Am. Soc. C.E.*
F. Methods of Making Society's Salary Schedule Effective Locally
G. The Society's Attitude Toward Its Juniors and Activities in Their Behalf, SCOTT B. LILLY, *Chairman, Committee on Juniors*
H. Junior Participation in Section Activities
I. Sub-Sections as a Means of Extending a Section's Service to Members
J. Where Does Your Dollar Go? GEORGE T. SEABURY, *Secretary, Am. Soc. C.E.*

Hotel Accommodations and Announcements

Hotel Rates, Denver Hotels

HOTEL	SINGLE ROOMS		DOUBLE ROOMS	
	With Bath	Without Bath	With Bath	Without Bath
Brown Palace	$3.50–6.00	...	$5.00–9.00	...
Cosmopolitan	3.50–5.00	$2.00	6.00–8.00	$3.00
Shirley-Savoy	2.50–3.50	2.00	4.00–7.00	3.00
Cory	2.50	...	3.50–4.50	...

The above hotels are within a block of the Headquarters Hotel.

Argonaut	$2.50–4.00	$1.50–2.50	$4.00–6.00	$2.50–4.00
Olin	2.50–4.00	...	3.50–6.00	...

The above hotels are less than one mile from the Headquarters Hotel.

The Brown Palace is the Society Headquarters for the Convention.

Members are urged to make definite arrangements for rooms at least a week in advance of the Annual Convention, paying for the rooms in advance for at least part of the period for which they expect to be in Denver.

Broadmoor Hotel, Colorado Springs

For those who may visit Colorado Springs following the Convention, the following rates for the Broadmoor Hotel are given:

Single Rooms:	
American Plan	$ 9.00 per day and up
European Plan	5.00 per day and up
Double Rooms (two persons):	
American Plan	$16.00 per day and up
European Plan	8.00 per day and up

All who attend the Annual Convention are requested to register immediately upon arrival at meeting headquarters. Special badges and tickets will be obtained at the time of registration.

Golf Information

Members desiring to play golf are requested to consult the registration desk.

Information

A registration desk will be provided in the headquarters hotel to assist visiting members in securing any desired information about the city. At the registration desk, a card file of those in attendance will be maintained, with information as to the members' Denver addresses.

Order All Tickets in Advance

Members who order tickets in advance not only will be saved delay by having tickets and badges awaiting them on arrival at headquarters, but they will assist the committee greatly by giving advance information to guide it in concluding arrangements.

Entertainment for the Ladies

Attention is directed to the entertainment provided for the ladies. It is expected that they will participate with the members in any other features of the program in which they are interested.

Invitation to Juniors and Members of Student Chapters

Juniors and members of Student Chapters are invited to participate in all the events of the Annual Convention.

See Page 24 of Advertising Section for Ticket Order Form

Local Committees on Arrangements

Executive Committee

NORMAN W. FUNK, *General Chairman*

PAUL S. BAILEY — T. J. NOLAND, JR.
ROY A. KLEIN — RALPH N. TRACY

Technical Program Committee

ROBERT FOLLANSBEE, *Chairman*

RODERICK L. DOWNING — OLIVER C. REEDY
IVAN E. HOUK — ROYCE J. TIPTON

Hotel and Registrations Committee

LYMAN F. COPELAND, *Chairman*

J. WAYNE COURTER — RUSSELL D. WELSH
OLIVER C. REEDY — FREDERICK W. WHITESIDE
JESSE E. WILLIAMS

Entertainment Committee

WILLIAM H. HAMILTON, *Chairman*
RUSSELL W. JAMES, *Vice-Chairman*

DEANE E. CARBERRY — CHARLES C. MCNAMARA
ROLLA P. LEBARON — JACOB E. WARNOCK

Publicity Committee

LOUIS R. DOUGLASS, *Chairman*
DIRK A. DEDEL, *Vice-Chairman*

ARTHUR W. ARLT — JOHN MCGOWAN
DANA E. KEPNER — ISADORE K. SILVERMAN

Reception Committee

ARTHUR O. RIDGWAY, *Chairman*

FREDERICK C. CARSTARPHEN — RALPH L. PARSHALL
HERBERT S. CROCKER — HJALMAR T. PERSON
CLARENCE L. ECKEL — FRANK O. RAY
BYRON W. MATTESON — CHARLES D. VAIL
RAYMOND F. WALTER

Finance Committee

WILLIAM B. FREEMAN, *Chairman*

FRANCIS C. HART — EARL L. MOSLEY
ARTHUR S. HORNER — MAXWELL A. NEWELL
ALBION K. VICKERY

Transportation Committee

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I. A. WINTER, *Electrical-Mechanical*
E. B. DEBLER, *Project Investigation*
IVAN E. HOUK, *Technical Investigation*
H. G. CURTIS, *Canals*
J. H. A. BRAHTZ, *Photoelastic Analysis*

Ladies Committee

MRS. PAUL S. BAILEY, *General Chairman*

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MRS. L. R. DOUGLASS — MRS. HARRY L. POTTS
MRS. CLARENCE L. ECKEL — MRS. P. J. PRESTON
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MRS. ROBERT FOLLANSBEE — MRS. OLIVER C. REEDY
MRS. NORMAN W. FUNK — MRS. ARTHUR O. RIDGWAY
MRS. C. A. GOULD — MRS. CHAS. SACRA
MRS. ROY C. GOWDY — MRS. E. R. SCHULTZ
MRS. D. D. GROSS — MRS. C. F. SEIFRIED
MRS. WILLIAM H. HAMILTON — MRS. M. A. SEILER
MRS. J. J. HAMMOND — MISS MARIAN E. BARNES
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MRS. F. C. HART — MRS. RALPH N. TRACY
MRS. M. C. HINDERLIDER — MRS. C. P. VETTER
MRS. A. S. HORNER — MRS. R. F. WALTER
MRS. IVAN E. HOUK — MRS. JACOB E. WARNOCK
MRS. D. J. HUNT — MRS. W. W. WEBER
MRS. RUSSELL W. JAMES — MRS. RUSSELL D. WELSH
MRS. ROY A. KLEIN — MRS. F. W. WHITESIDE
MRS. S. B. LAMB — MRS. JESSE E. WILLIAMS
MRS. I. A. WINTER

The program as a whole has been prepared under the direction of the Western Region Meeting Committee, composed of JOSEPH JACOBS, *Vice-President, Am. Soc. C.E., Chairman;* and CHARLES GILMAN HYDE, CHARLES T. LEEDS, and GLENN L. PARKER, *Directors, Am. Soc. C.E.*

Please call on the Local Committee on Arrangements or on the Secretary's office for any service desired.

THE CONTINENTAL DIVIDE IN ROCKY MOUNTAIN NATIONAL PARK

SOCIETY AFFAIRS

Official and Semi-Official

Census for Construction Preparedness

Listing Professional Talent for Design and Supervision of National Defense Facilities

NATIONAL DEFENSE is uppermost in thinking today. Personnel preparedness for the construction of facilities for defense is being developed vigorously under the leadership of the Society and the American Institute of Architects, in cooperation with nine other engineering societies, which have formed the National Committee on Construction Preparedness. A census of the total national professional abilities for the design and the supervision of construction—that is, technical leadership—is well advanced. Plans are needed first—after that, structures of every conceivable kind.

Personnel data on over a hundred thousand engineers and fifteen thousand architects throughout the country are the objective. The engineering end of this program is being handled through the Society. The first step was to obtain the names and addresses of any and all engineering firms, or individuals, in private practice. These have been furnished by the Local Sections of the Society for their respective areas; and by the other cooperating engineering societies through their headquarters and their local sections. This listing was not limited to members of these societies. Directories and telephone books have been searched and all those who might aid were included. Due to the remarkable energy and thoroughness with which the sections and the societies supplied the requested material, the whole vast inquiry has proceeded with speed and accuracy.

NATIONAL CENSUS OF ENGINEERING FIRMS

The second step was the development of a Master List, from which duplicates were eliminated as far as possible at Headquarters, and which will serve as "History" records of the use made of the accumulated data.

Step three was the mailing of a questionnaire to all the offices and individuals thus obtained and placed on the Master List. To date questionnaires have been mailed to 3,500 engineers, a thousand of which have already been returned and classified. The questionnaire, both sides of which are reproduced herewith, is identical for engineers and for architects. The face of the questionnaire affords opportunity for demonstration of the strength of present organization both in personnel and in experience. The reverse permits indication of special qualifications for engagements in many specialties.

Thus, a variety of data is being assembled. Each firm or individual classified its respective skill in the design and supervision of construction of such works as airports with the necessary drainage, runways, hangars, administration buildings, and housing facilities; water supply and purification plants; sewage and industrial-waste disposal systems; roads, bridges, and tunnels; the enlargement of industrial plants with the necessary water and disposal systems, and housing facilities for workmen; port developments with loading docks, wharves, warehouses, and railroads; and cantonments with barracks, water, sewage, heating, lighting, and other systems, and the necessary mechanical, refrigerating, and ventilating accessories.

The Society's augmented staff rapidly filed and cross-indexed the data indicated by the returned questionnaires to the end that ready reference may be had by name, locality, and as to both major and secondary special qualifications. The questionnaires now being assembled and indexed at Headquarters are in the form illustrated herewith.

LOCAL CENSUS OF AVAILABLE ENGINEERS

The next step was the similar gathering and classification of engineers, designers, draftsmen, surveyors, and others capable of being utilized by the firms or individuals who will undertake the design and supervision of construction of projects assigned to them. This is being done by the Local Sections. It appears both practicable and advisable to assemble locally these necessary data with

CLASSIFICATION OF ENGINEERING AND ARCHITECTURAL FIRMS
FOR DESIGN AND SUPERVISION OF CONSTRUCTION OF FACILITIES FOR NATIONAL DEFENSE

A—AIRPORTS AND LANDING FIELDS
1. Drainage
2. Hangars and Buildings
3. Housing Facilities
4. Lighting
5. Radio Towers and Control Equipment
6. Runways

B—BUILDINGS
1. Commercial
2. Hospitals
3. Industrial
4. Mechanical Equipment (See K)
5. Schools

C—COMMUNITY PLANNING
1. Housing
   (a) Furniture and Furnishings
2. Industrial Towns
3. Landscape Work
4. Municipalities

D—DAMS AND LOCKS
1. Arched and Reinforced Concrete
2. Concrete and Masonry Gravity Dams
3. Earth, Hydraulic Fill and Rock Fill Dams
4. Movable Dams, Timber Dams
5. Locks
6. Water Resources and Hydrology

E—ELECTRICAL
1. Communications
2. Distribution Lines
3. Generation
4. Lighting Systems
5. Power Control Equipment
6. Transmission Lines

F—FOUNDATIONS
1. Piles and Pile Driving—Concrete, Metal, Timber
2. Pneumatic and Open Caissons
3. Soil Mechanics
4. Underpinning

G—HARBORS, PORTS AND WATER WAYS
1. Breakwaters and Jetties
2. Canals
3. Coast Erosion and Protection
4. Derricks, Cranes and Hoists
5. Docks, Piers, Quays, Wharves, Bulkheads
6. Dredges and Dredging
7. Dry Docks and Ship Yards
8. Fortifications
9. Harbors, Roadsteads and Anchorages
10. River Regulation and Canalization

H—HIGHWAYS
1. Bituminous, Brick, Concrete, Surfaces
2. Construction
3. Location
4. Low Cost Roads
5. Maintenance

I—INSPECTION OF
1. Construction Work
2. Materials of Construction

J—MATERIAL HANDLING EQUIPMENT

K—MECHANICAL EQUIPMENT FOR BUILDINGS AND PLANTS
1. Air Conditioning
2. Compressed Air Distribution
3. Elevators
4. Heating
5. Lighting
6. Plumbing
7. Refrigeration
8. Steam Distribution
9. Ventilating

L—MINERAL INDUSTRIES PLANTS
1. Coal
2. Iron and Steel
3. Non-Metallic Minerals
4. Non-Ferrous Metals
5. Petroleum

M—POWER PLANTS
1. Hydro-electric
2. Internal Combustion
3. Steam

N—RAILROADS AND RAILWAYS
1. Buildings
2. Construction
3. Electrification
4. Industrial Railways
5. Inter-urban and Street
6. Location
7. Maintenance of Way and Structures
8. Shops
9. Signals and Signaling
10. Yards and Terminal Facilities

O—RECLAMATION OF LAND
1. Drainage
2. Irrigation

P—SANITARY ENGINEERING
1. Camp Sanitation
2. Garbage and Municipal Waste Disposal
3. Industrial Waste Disposal
4. Sewage Disposal
5. Sewerage Systems

Q—STRUCTURES
1. Army Cantonments
2. Bridges
3. Buildings (See B)
4. Coal Storage Plants
5. Grain Elevators

R—SURVEYING AND MAPPING
1. Aerial Surveying
2. Geodetic and Triangulation
3. Lines and Grades
4. Topographic Surveying

S—TUNNELS AND SHAFTS
1. Earth Tunnels
2. Grouting, Lining
3. Rock Tunnels
4. Subways
5. Underwater Tunnels and Shafts
6. Quarrying

T—WATER WORKS
1. Canals, Tunnels, Aqueducts
2. Distribution Mains and Services
3. Industrial Supply
4. Pumping Plants
5. Rural and Isolated Supplies
6. Storage Works
7. Water Treatment Plants

REVERSE SIDE OF THE QUESTIONNAIRE

NATIONAL DEFENSE

NATIONAL CENSUS OF ENGINEERING AND ARCHITECTURAL PERSONNEL

Design and Supervision of Construction

In connection with a nation-wide census of Engineering and Architectural firms (or individuals), available for the design or supervision of construction of facilities for national defense, you are urged to fill out this questionnaire and return it promptly to the address shown below.

All Engineers to:
American Society of Civil Engineers
33 West 39th Street,
New York, N. Y.

All Architects to:
American Institute of Architects,
The Octagon,
Washington, D. C.

Mail in Triplicate

1. Name of Firm (or individual) _____ *(Please type)*
2. Address _____
3. Branch offices, if any _____
4. Date established _____
5. Character of work (Use letters and numbers. See reverse. Amplify as needed) _____
6. Number of partners and names _____
7. Number of other principals _____
8. Average number in organization, including partners, principals and staff _____
9. Recent typical commissions (name, date, construction cost) _____
10. Are you customarily engaged also in construction work either directly or through subsidiaries, and if so, how _____

_____ *Signature*

_____ *Title*

Four copies enclosed. One for your files

FACE OF THE QUESTIONNAIRE

respect to the many thousands of such men who will be needed at different points in the country. The Local Sections therefore have undertaken to discover, list, and classify these men at some central point in each state.

In the preparation of the entire census will be observed the fundamental principle of avoiding the dislocation of those now engaged in essential industries, utilities, and governmental organizations. It is of paramount importance that the valuable engineering staffs of these organizations be maintained available in any called-for expansion of functions. Account is also taken of those in the National Guard or Reserve Corps.

Mention has been made of the splendid cooperation of the Local Sections of the Society. Similarly, great credit should be accorded the secretaries and staffs of other national engineering societies. Nine such national engineering organizations have collaborated generously with the Society in providing lists of engineers in their special fields as they relate to construction. These societies are: the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, American Institute of Consulting Engineers, American Society of Heating and Ventilating Engineers, Society of American Military Engineers, American Society of Refrigerating Engineers, and the National Society of Professional Engineers.

The Society has attacked this problem without stinting effort or expense.

Joint Concrete Report Available

AS A RESULT of many years of intensive study, the report, "Recommended Practice for the Use of Concrete and Reinforced Concrete," is now available to engineers. Members of the Society have received it as Part 2 of the June PROCEEDINGS. The report is the product of a joint committee, made up of representatives of the Society and five other organizations.

Judging by the interest shown in this work, the report will be in considerable demand in the everyday practice of those who deal in concrete. For this reason, reprints have been made and are available through the Society. In the belief that the report not only will be useful for a number of years, but also will have intensive daily handling, a special form has been arranged for durability and convenience in practice.

With this thought in mind a heavier cover paper and special binding have been employed; also a special stitching which causes the booklet to lie conveniently flat when opened on a drafting or design table. The volume comprises 136 pages. It is being made available for general distribution at a price of $1.50 per copy. Members of the Society will receive the regular 50% discount. A special price is made for members of Student Chapters of the Society, who may obtain their individual copies at fifty cents each.

The report refers to a number of Standard Specifications of the American Society for Testing Materials. In all, 26 such specifications are mentioned. As a matter of convenience, the A.S.T.M. has therefore gathered together these 26 specifications in a single booklet and has courteously agreed that the Society may distribute copies under the same terms that it is furnishing them to its own members. As long as the supply lasts, therefore, this booklet of specifications may be ordered through the Society at the price of fifty cents a copy.

These two pamphlets are expected to meet a long-felt need for an up-to-date statement of present-day practice in concrete. The new report should therefore take the place of the 1924 report, which was in continuous demand until superseded by the present document.

Engineering Societies Personnel Service, Inc.

IN ORDER to satisfy certain legal requirements of the several states in which it operates, the employment service of the Four Founder Engineering Societies has been incorporated in New York State and its name changed to Engineering Societies Personnel Service, Inc. Over a period of 17 years, the Service, through its offices in New York, Chicago, and San Francisco, has placed more than 20,000 engineers in private industry, and, from 1930 to 1939, more than 10,000 on WPA and other governmental projects.

At the first meeting of the corporation, held in the Engineering Societies Building in New York, Monday, June 10, plans were made to extend the operations of the Service to a greater degree. George T. Seabury, secretary of the American Society of Civil Engineers, was elected president; C. E. Davies, secretary of the American Society of Mechanical Engineers, vice-president; Otis E. Hovey, Hon. M. Am. Soc. C.E., director of the Engineering Foundation, treasurer; and A. H. Meyer, secretary.

It was announced that the present staff of the Service will continue in their present positions with the corporation. Members of the staff include Walter V. Brown, manager, New York office; Thomas Wilson, manager, Chicago office; and Newton D. Cook, manager, San Francisco office.

Engineering Trends in California

A Study of Employment Classifications of Society Membership, 1924–1939

By R. O. THOMAS, JUN. AM. SOC. C.E.

JUNIOR ENGINEER, RAPID TRANSIT DESIGN, BUREAU OF ENGINEERING, LOS ANGELES, CALIF.

ANALYSIS OF the professional connections of members of the American Society of Civil Engineers in the State of California, covering the period from 1924 to 1939, discloses several very interesting facts. Assuming that the membership of the Society represents a fair cross section of the civil engineering profession as a whole, certain distinct trends are occurring in professional employment which should be of interest to all who have the future of the profession at heart.

All data were secured from the Society's annual Year Books for 1924, 1929, 1934, and 1939, from which the professional connections and grades of membership were tabulated for each member resident in California. The particular years selected were used because they represent certain outstanding periods in the recent history of this state. The year 1924 saw the culmination of the extremely rapid post-war rate of growth which this state experienced following the armistice; 1929 was very close to the peak of prosperity, with building, industry, and engineering construction at practically an all-time high; 1934 is an index to the professional condition of engineers shortly after the federal government commenced widespread spending for construction activities; and 1939, of course, represents conditions at the present writing, with all types of activity showing a sharp upturn in recent months.

Types of professional employment were divided into six main classifications:

1. Public Service, including those in the employ of semi-private districts, such as irrigation districts.
2. Professional Practice, consisting only of consultants and their assistants.
3. Professional Service, including professors of engineering and those engaged in other professions, such as law or architecture.
4. Engineering Commerce consisting of those employed by commercial and industrial activities which depend primarily on engineering and technical knowledge. It was assumed that members employed in these connections were engaged in the technical branch of the business.
5. Non-Engineering Commerce, or such activities as sales, finance, insurance, and so forth.
6. Other Groups, including those holding non-engineering political positions, retired members, and those not stating their professional connection.

Each of these main classifications was again further divided into three to six subdivisions, and the number of Members, Associate Members, Juniors, and Affiliates in each group tabulated separately. A set of condensed tables (Tables I and II) are presented herewith. (Space does not permit including the entire series of tables in this article, but they have been placed on file in the Engineering Societies Library where they may be consulted by those interested.)

TABLE I. DISTRIBUTION OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS IN CALIFORNIA, 1924–1939

CLASSIFICATION	NUMBER OF MEMBERS				% INDEX OF GROWTH (1924 = 100%)			
	1924	1929	1934	1939	1924	1929	1934	1939
Public Service	200	418	570	891	100	209	285	445
Professional Practice	291	361	271	287	100	124	93	99
Professional Service	45	62	80	79	100	138	178	175
Commerce (Engineering)	246	354	346	433	100	145	141	176
Commerce (Non-Engineering)	46	61	70	72	100	131	152	156
Other Groups	149	184	424	223	100	123	284	149
Total membership	977	1,440	1,761	1,985	100	147	180	207

In California, during the year 1939, there was resident approximately 12.4% of the total membership of the Society, or 1 out of every 8. Data gathered in the recent Factual Survey (made by the Committee on Salaries) appear to indicate that the conditions as found in California are quite representative of those in the United States as a whole. The percentages of membership in various employment groups are quite similar, the greatest discrepancies being found in the "Public Service" and "Others" classifications. It appears that most of those who do not state their professional connections in their Year Book listing are probably in the government service.

The most noteworthy trend in employment revealed in the course of the study was the rapidly increasing proportion of the total membership in public employment, and the decreasing percentage in professional practice (Fig. 1). The percentage of those engaged in commercial and industrial pursuits remained approximately constant. This trend occurred both through pre-depression and depression times, continuing up to the present. While the membership in the state doubled during the 15-year period, the number in public service increased 445%, but the number in professional practice barely remained constant. The proportion of the membership engaged in public service increased from 20.5% in 1924 to 44.9% in 1939, while those in professional practice decreased from 29.8% in 1924 to 14.4% in 1939.

TABLE II. SEPARATE DATA ON JUNIORS

YEAR	PROPORTION OF JUNIORS IN SOCIETY AS PERCENTAGE OF TOTAL MEMBERSHIP		PERCENTAGE OF CALIFORNIA JUNIORS IN EACH OF TWO EMPLOYMENT CLASSIFICATIONS	
	Nationwide	California Alone	In Public Service	In Professional Service
1924	5.6	5.8	24.6	21.0
1929	14.9	14.6	40.8	13.3
1934	20.2	17.9	34.6	2.2
1939	24.4	23.5	52.4	5.4

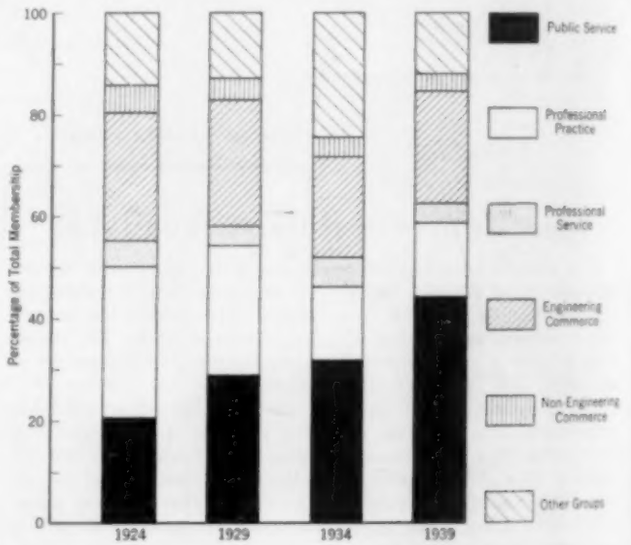


FIG. 1. EMPLOYMENT CLASSIFICATION OF SOCIETY MEMBERS IN CALIFORNIA, 1924–1939

If the trends indicated in Fig. 1 are projected into the future, one might hazard the prophecy that the private consultant will have practically disappeared by 1960, twenty years from now. While a strict extrapolation of the curve of public service would indicate that by 1970 all engineers would be in that classification, it is reasonable to assume that the proportion engaged in commerce and industry will remain approximately constant in the future, as it has in the past. A practical forecast for 1970, or thirty years from the present time, would be somewhat along the following lines: 75% of the membership in public service, 5% in private practice, and the remaining 20% in commerce, industry, or engaged in non-engineering pursuits.

A number of trends of particular interest to Juniors are indicated in Table II. The proportion of Juniors to the total membership

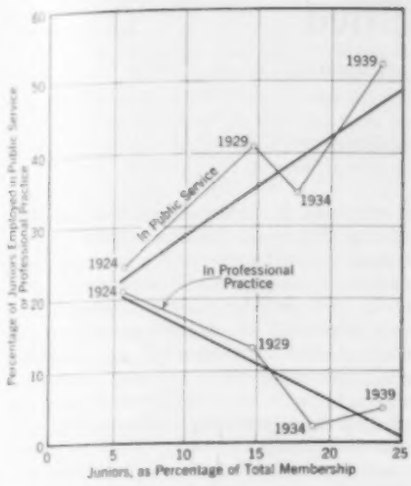


FIG. 2. SHOWING GROWTH OF PERCENTAGE OF JUNIORS IN CALIFORNIA, 1924–1939, AND CONCURRENT CHANGE IN EMPLOYMENT CLASSIFICATION

in this state increased from 5.8% in 1924 to 23.1% in 1939. The number employed in private practice has decreased from 21.0% to 5.4%, and the number in public service increased from 24.6% to 52.4% during the 15-year period. A graphic presentation of these data is given in Fig. 2.

One wonders if the large number of Juniors in public service, where the opportunities for responsible work are extremely limited, has any relation to the high ratios between Juniors dropped at the age of 32 to those transferring to the grade of Associate Member. On January 1, 1938, there were 3,610 Juniors in the Society. During the year, 185 Juniors transferred to the grade of Associate Member, while 128, or 69% as many as transferred, were dropped on account of age. Although the year showed a total gain in Junior membership, there was a loss of 548 Juniors, only 185 of whom (as above), or 34%, were transferred to the higher grade. This trend may bear study in relation to its effect on the future membership of the Society.

The writer would be glad to see a full discussion of this article ensue, as he believes that the subject matter is of interest to the Society as a whole, bound up as it is with the professional prospects of the future. Credit is due to Donald M. Baker, M. Am. Soc. C.E., who suggested the initiation of this study and made valuable suggestions regarding its scope.

Two-Day Meeting of Alabama Section at Montgomery

ONE OF the most ambitious programs ever arranged for the Alabama Section was its recent spring meeting. A two-day session, April 30 to May 1, was scheduled for the capital city, Montgomery, rather than, as previously, in Birmingham. This innovation attracted a great many members as well as students and visitors.

Formalities and introductions occupied the first part of the session on Tuesday afternoon. Then came the technical discussion, opened with a paper by Roy S. Garrett, describing the history and progress of road work around Montgomery. Continuing the discussion of highway development and administration in the state, George Moulton next presented a paper on recent developments in the state highway department. Finally, a third paper by Chris J. Sherlock dealt with the administration of the state road construction.

At a second discussion immediately following, three papers were presented: Prof. T. M. Lowe described the Marine Studio in Florida; Col. W. G. Henderson treated the subject of WPA in its municipal operation; and Harry H. Hendon discussed sewage disposal, both in Alabama and in Europe.

Almost 100 persons attended the banquet that evening. Opportunity was given for the introduction of local and university guests, including members of Student Chapters. National Society officers also were on the program—there were brief talks by President Hogan, Secretary Seabury, and Director Polk.

The Wednesday morning session, similar to the one on the previous afternoon, was divided into two main parts. Of these the first covered the interests of the state highway department, in three papers. The first of these, by J. L. Land, dealt with the state testing laboratory; he was followed by H. K. Stevenson, who discussed current bridge developments; and finally, Frank Garrett analyzed causes and prevention of highway accidents.

After an intermission, the second part of the program was devoted to government engineering activity. Lieut. James H. C. Houston read a paper on the role of aerial maps and photography in mapping and Col. Richard Park covered the subject of navigation and flood control projects in Alabama.

With the technical part of the program thus completed, the remainder of the day was devoted to local inspections. The entire group, in automobiles, first visited a large highway bridge project across the Tallapoosa River at Tallassee, where they could view the process of steel construction. Following this, the group divided up into smaller parts and visited the hydroelectric plant of the Alabama Power Company, as well as large textile mills nearby.

This type of Section meeting was considered most successful, reflecting the interest of state-wide membership and the excellent local arrangements. It is expected that future meetings, following this plan, may be held at Mobile and elsewhere throughout the state.

Construction in Rhyme

ONE OF the high lights of the spring meeting of the Tennessee Valley Section, which was held at Hiwassee Dam, was a "paper" describing experiences with the construction plant. By assigning this subject to John F. Partridge, M. Am. Soc. C.E., the Section brought to light a budding poet laureate—his paper was entirely in rhyme.

By courtesy of the Section officers, we are privileged to quote two stanzas herewith, just by way of a sample:

Speaking concretely, not much need be said,
We poured and we poured till we were nigh dead.
Morning and night, that bucket did fly
And the drone of the motors never did die.
The problem was simple, but we did want to know
Whether concrete we placed was to be high or low;
When outhaul was great, and the return took some time,
Even a nine-yard bucket would have been fine.
We did have a six and a seven point five,
The former for short haul, and man alive
When we needed capacity and didn't mind time,
We threw her in high—overtime was a crime.

I would like now to mention our 8-inch formed drains—
They proved such a nuisance, that when we try them again
We think we could drill them clean through from the top.
We make the suggestion—and question, why not?
The five per cent slope towards the upstream face
Proved no hindrance in building, once the forms were in place;
It helped in the cleaning, and if finished with care,
The steel keyway forms could be set to a hair.
And the cooling pipes, we discovered with glee,
Reduced our heat to the proper degree;
At very small cost, it should be said,
Since we drew our water from the river bed.

The entire paper as given by Mr. Partridge is expected to be published in the Section's own monthly periodical, *The Tennessee Valley Engineer*. Those who are interested in this important project may wish to refer to Mr. Pearce's article on the dam in the June issue of CIVIL ENGINEERING, and to his second article on the same subject in the present number.

New Employment Office in Detroit

A FOURTH regional branch of the Engineering Societies Personnel Service, Inc., is scheduled to be opened on July 1, the new office to be in Detroit, Mich. It will be recalled that this organization is a continuation, under a new name, of the previous Engineering Societies Employment Service.

For the Detroit work, Louis E. Williams has been selected as branch manager. He is well acquainted with local conditions and has had extensive experience around Detroit. It is believed that this new extension will enlarge the scope of engineering employment activities by bringing this office to one of the largest centers of engineering work. The other offices, in New York, Chicago, and San Francisco, have long been in operation.

Professional Objectives Outlined

FROM A REPORT PREPARED AT THE REQUEST OF THE MID-SOUTH SECTION

By L. L. HIDINGER

CHAIRMAN, MID-SOUTH SECTION'S COMMITTEE ON PROFESSIONAL OBJECTIVES

IN 1938 the Board of Direction of the Society appointed a Committee on Professional Objectives. The functions and objectives of this committee were specified as follows:

"1. To supplement and strengthen the work of the Board of Direction and the professional committees of the Society in the professional improvement of its members.

"2. To concern itself actively with subjects incident to the professional practice of engineering with the objectives of developing and maintaining high standards of practice and ethics, promoting understanding among engineers and between the profession and the public, and increasing the usefulness of the profession to society.

"3. To endeavor to facilitate the working together of those members of the Society who are particularly interested in the affairs and development of both salaried and employer engineers; providing an agency through which these members may express themselves more freely and effectively on professional matters.

"4. To give general consideration to national and state legislation affecting the engineer and to give general consideration to the development of both the individual engineer and the development of the group, and the responsibility of the engineer to society.

"5. To give particular consideration to the economic and social status of the engineer and to national and social trends affecting the same; together with consideration of all the humanities of the engineering profession.

"6. To encourage and demand a wider employment of engineers in engineering, technical works, and in the management and direction of engineering and technical works, so as constantly to increase a public demand for engineers in all types of engineering work and for technical responsibility by the engineer in management, administration, planning, and public works."

These statements in simple form refer to the professional, the social, and the economic standing of the engineer. The improvement of the status of the engineer in each one of these fields is, in the last analysis, fundamentally dependent upon public opinion, and advancement cannot be ultimately obtained without the public's being convinced that a higher status is merited. To this end an aggressive program for public favor based on professional merit is fundamental; group action is important; an increase in membership is desirable; the registration laws must be enforced; the professional, technical, and ethical standards of the profession must be improved; and last, but not by any means least important, is favorable publicity.

The public's appraisal of the technical training and ability of the engineer fixes his professional status. His character, personality, and standing in the community fix his social position, and his commercial value to the tax-paying public establishes his economic position.

It appears desirable to outline these three objectives somewhat in detail:

PROFESSIONAL STANDING

Registration is one of the primary and desirable means of improving the engineer's professional standing. Theoretically, the registration laws in the several states are capable of (1) determining the technical qualifications of applicants, (2) preventing the use of the title "Engineer" by those not qualified to use it, (3) disciplining those who violate the law, and (4) prosecuting those who practice illegally.

If the standards of the profession are to be elevated, these laws must be strictly enforced, and attention to enforcement must be given by engineers of standing in order to make the laws effective. Where enforcement of the registration law is lax, steps should be taken at once to make it more effective.

The plumber who calls himself a sanitary engineer, the building contractor who calls himself a structural engineer, the real estate salesman who calls himself an appraisal engineer, and any other unqualified person who represents himself as being an engineer, must be stopped from using such titles.

Another feature that will tend to raise the professional standing of all engineers is membership in the Society. Such membership will lead to a larger concentrated group with a common objective and much wider influence than widely scattered, unorganized individuals. Furthermore, such membership will, when known by the public, elevate its opinion of the individual engineer. If civil engineers are to make a place for themselves professionally, they must affiliate themselves with their national engineering society and let the whole world know about it. Such membership will tend to make engineers as a class professionally minded. All too many engineers are professionally illiterate. They do not see the advantages or the necessity of advancing the profession as a whole and thus advancing their own standing. Only as the units are lashed firmly together as a whole will the standing of the engineering profession, and thus of the individual engineer, be advanced.

Steps should be taken to give Juniors more responsibility in the affairs of the Society and to keep in close contact with student members, looking toward the education of both in the traditions and objectives of the engineering profession to the end that they may become professionally minded and realize that it is to their advantage to assist in improving the standing of the profession.

A strict observance of high ethical standards by all members of the engineering profession will elevate the profession as a whole, and its standing in the community. The Society has a standard code of ethics that can be referred to as a basis when there is uncertainty, but the best code of ethics in existence is the Golden Rule. If this rule is followed, not only will the profession be elevated in public esteem, but the individual will also be.

SOCIAL STANDING

The social standing of the engineer as an individual will, in the long run, determine the standng of the profession as a whole. If the status of the profession is to be elevated, social improvement is imperative. To that end education in the arts is fundamental; training in human relations is essential; public prominence is necessary; and training for and participation in political activities is desirable.

The legal and medical professions require two to four years' study of the arts before the student is admitted to a technical training course. Our profession should do likewise. A study of the liberal arts would supply a background that would broaden the individual and enable him to attain a higher standing in his community.

General education is becoming an essential for all who aspire to leadership in public life. The basis for such education lies in college training, to be later followed up by the self education that is necessary in all the professions and activities of life if one is to keep abreast of the times. Neither the social graces nor social standing can be acquired from any curriculum. The chief source, if not the only source, is self education. Culture can be acquired by a study of the elements that tend to produce it as well as association and contacts with those who already possess it.

ECONOMIC STANDING

The economic status of the individual engineer depends to a large extent on the standing of the engineering profession as a whole. It therefore behooves the individual to become an active agent in the betterment of the profession.

The Society has long been active in studying the economic status of the individual engineer and setting up standards to assist him in securing remuneration on the same scale as other engineers doing similar work.

Analyses are made from time to time of the income of engineers in all classifications and localities, and the information has been disseminated through the publications of the Society. Furthermore, specific studies have been made of groups of engineers in a certain classification to show the employing agency that other similar groups, similarly employed, are receiving larger compensa-

tion, and that information has been placed directly before the employing agency.

An employment bureau was maintained by the Metropolitan Sections of the Founder Societies (P.E.C.U.) at Society headquarters for several years during the worst of the depression in the early thirties, and similar bureaus were maintained by many of the larger Local Sections. The Founder Societies maintain an employment service and several Local Sections render similar service to their members.

The aims of a Local Section's Committee on Professional Objectives might be summarized as follows:

1. Increase membership.
2. Enforce registration laws.
3. Secure favorable publicity.
4. Improve the ethics of the individual engineer.
5. Improve the social standing of the individual engineer.
6. Give Juniors more responsibility in the affairs of the Local Section and the Society.
7. Keep in close contact with Student Chapters in the Section's area.
8. Assist engineers, especially in the lower grades, in improving their income by securing better positions and better salaries.

In these observations I have endeavored to outline the scope and basis of operations of the Society's Committee on Professional Objectives. Similar committees for all Local Sections are the agencies to work directly with the membership in this connection.

Texas Section Meets at Galveston

ALL SOCIETY members in Texas made an effort to attend the spring meeting of the Section in Galveston on Friday and Saturday, April 26 and 27. Some, indeed, got there beforehand, so that President L. R. Ferguson was able to round up 60 or more for dinner the night of April 25. The meeting was given a national flavor by the presence of President Hogan, Director Bres, and Secretary Seabury.

Greetings and formalities having been properly provided for, the first session on Friday enjoyed interesting pictures of construction at the Agricultural and Mechanical College of Texas, by Alfred Finn, Jr. This was followed by an address giving results of the Texas state-wide planning survey, by G. G. Edwards, covering over 20,000 miles in the state highway system and 165,000 miles of country roads. Discussion was extensive and interesting. In the afternoon the subject of bituminous stabilized soil for roads was

FRIDAY LUNCHEON AT SPRING MEETING OF TEXAS SECTION
Left to Right: Edward S. Bres, Director; John P. Hogan, President of the Society; R. J. Cummins, President of Texas Section; and H. R. F. Helland

comprehensively presented by Charles Haile and received considerable discussion. This was followed by a second paper on the nearby activities of the Corps of Engineers, described by Col. F. S. Besson. Including student members who were able to be present at some of the sessions, the total attendance amounted to almost 200.

During the evening 150 members and guests met for a dinner dance. This affair was enlivened by music and dancing demonstrations, particularly exhibitions of the Virginia reel and the square dance by Dean T. U. Taylor.

On Saturday morning a business session was first on the program. President Cummins supervised the presentations of life certificates to F. E. Giesecke, E. C. Woodward, J. L. Lytel, S. W. Henderson, and J. W. Stewart. Progress reports and resolutions were also presented. The high light of the session was a talk on ethics by Dean Taylor, who emphasized that the engineer should (1) be as straight as a B-line; (2) remain as square as 90 degrees; (3) have all his acts based on the bench mark of honesty. Students were particularly invited to hear this talk.

Other social events included a Sea-Train Port demonstration at Texas City on Friday afternoon and a boat trip through Galveston Harbor on Saturday afternoon. In connection with this splendid meeting, there was also a fine Student Chapter Conference, which is reported elsewhere in more detail.

Appointments of Society Representatives

D. C. ANDREWS, Assoc. M. Am. Soc. C.E., has been appointed to represent the Society on the Board of Standards and Appeals in the New York State Department of Labor, concerning revision of Industrial Code Bulletin No. 23. WILLIAM J. BARNEY, M. Am. Soc. C.E., has been appointed alternate.

R. E. BAKENHUS, M. Am. Soc. C.E., has been appointed one of the Society's representatives on the Engineers Council for Professional Development for the three-year term, October 1940 to October 1943.

CHARLES B. BURDICK, M. Am. Soc. C.E., has been reappointed one of the Society's representatives on the Washington Award Commission.

CHARLES G. HYDE, M. Am. Soc. C.E., was appointed to serve as the Society's delegate to the meeting of the Society for the Promotion of Engineering Education, held at the University of California at Berkeley, June 24 to 28, 1940.

ARTHUR S. TUTTLE, Past-President Am. Soc. C.E., has been appointed to represent the Society on a Special Committee on "Inter-American Engineering Relations" of American Engineering Council.

Hints on Writing Biography

THE SOCIETY'S "Memoirs," as published yearly in TRANSACTIONS, constitute much more than a catalogue of professional records, each of which is important only to a small intimate group of colleagues. Rather, in a broad sense they paint a picture of the profession and its historical attainments, using a medium that is characteristic of the engineer—a body of itemized facts. But cold factual data are difficult to fashion even with literary artistry into an attractive story, and the results, as sometimes shown by the memoirs written for the Society, tend to be uninspiring even to the engineering reader.

In order to assist the voluntary writer of memoirs, a short list of guiding suggestions was published in CIVIL ENGINEERING for November 1937. That others find such suggestions of material help is attested by the following list of questions devised by Prof. Donald Bartlett, head of the Department of Biography at Dartmouth College, for guidance in analyzing careers. If the biographer can answer such questions, he may approach a more revealing story of a man through glimpses of a personality and of the effect of the interactions between an individual, his profession, and life. The questions are:

1. What led to the choice of the profession? External events, aptitude for professional details, appreciation of significance of the profession? Was there an obvious alternative?
2. What did he sacrifice for the choice?
3. How did the profession fit the man?
4. What opportunities did it open for him?
5. What would you have most enjoyed in his career?
6. What would have irked you most?
7. How did his career affect his domestic life? His association with his friends?
8. How did his religion affect his career? How did his career affect his faith and ideals?
9. What were the important causes of his eminence? What did he think were the important causes of his eminence?
10. Did he have a hobby? Worthy?

The foregoing list suggests some interesting thoughts that should be useful in the preparation of Society memoirs.

Ralph Budd Appointed to National Defense Commission

OF ALL the activities connected with the recent plans to stimulate preparedness, one of the principal steps has been the appointment by the President of a National Defense Commission, comprising leaders of great industrial and other branches of American life. It is most gratifying to engineers to know that one of our Society members, Ralph Budd, has been named on this commission.

RALPH BUDD

As the matter now seems to be developing, the commission is expected to coordinate and to intensify national preparation for defense. To this end its members represent leaders in the steel, automobile, and other industries. In this setup one of the main activities is rail transportation.

Because of his extensive experience, Mr. Budd has been chosen for this great responsibility. His lifetime has been spent in responsible work of this nature, commencing on the Panama Railroad and extending through later years, culminating in the presidency of the Great Northern Railroad and now, for almost ten years, of the Chicago, Burlington and Quincy Railroad.

Besides these business interests, Mr. Budd has been active in many fields. He was director of the Society for the term 1929–1931. He has served as Society representative on the Hoover Medal Board of Award. In addition he has contributed papers to CIVIL ENGINEERING, mostly on railroad matters.

Not only is his appointment a great compliment to engineers—it is a guarantee that his end of the defense work will be prosecuted with the utmost vigor and ability.

Honorary Membership to W. J. E. Binnie in London

ONLY RECENTLY has the certificate of Honorary Membership to W. J. E. Binnie of London been presented. Vote on this matter was taken by the Board of Direction last summer and it was expected that the ceremony would be enacted at the time of the British American Engineering Congress in September. When the war interfered, the occasion was put off until it could be handled under the proper auspices.

Thus it was that the arrangements had to be deferred until April 25, when the recipients of the honors to be conferred as well as the American Ambassador, Joseph P. Kennedy, could all be present in London. A luncheon was arranged at the Grosvenor Park Hotel at which His Excellency, the American Ambassador, was honored guest. About 50 notable English engineers attended, equally divided between the official representatives of the Institution of Civil Engineers and the Institution of Mechanical Engineers.

In addition to the bestowal of Honorary Membership in the Society on Mr. Binnie, a similar honorary membership was bestowed by the American Society of Mechanical Engineers on E. Bruce Ball. Messrs. Binnie and Ball were the presidents of the respective English institutions during 1939 when the international meeting was arranged. The ceremonies were brief. After the Ambassador, with a few appropriate words, had presented the certificates, each of the new Honorary Members of the American societies responded with a brief address. The whole atmosphere was one of cordiality and international friendliness.

In commenting upon his election to honorary membership, Mr. Binnie recalled that only five of his compatriots had been thus honored, the last being Sir Maurice Fitzmaurice and Professor Unwin, both deceased, who were elected in 1922. But the societies have other bonds in common; there are 78 members of the Institution who are likewise members of the Society, whereas 65 members of the Society reciprocate in belonging to the Institution. Originally Mr. Binnie's interest in the Society was aroused through his association with the late Colonel Hugh Cooper, when both were consultants for the Egyptian Government on raising the Aswan Dam for the second time.

In commenting upon these interesting associations, Mr. Binnie has written to the Society, "I have found your PROCEEDINGS of the greatest value and as an hydraulic engineer I have envied the opportunity which your vast continent affords for the construction of monumental works, such as the Boulder Dam."

A more extensive account of Mr. Binnie's long professional career and notable achievements appeared in the January issue.

Texas Student Chapter Conference

COVERING PARTS of two days and dovetailed in with simultaneous meetings of the Texas Section, a group of Student Chapters representing various Texas institutions met at Galveston, April 26 and 27. Over 60 students were in attendance, representing the University of Texas, Austin; Rice Institute, Houston; Agricultural and Mechanical College of Texas, College Station; Texas Technological College, Lubbock; Southern Methodist University, Dallas; and Texas College of Arts and Industries, Kingsville. The main business on the first session was the presentation of papers in a speaking contest, covering five subjects each by a student member of a different Texas college. The student meeting then joined the Texas Section in an adjoining room.

Some of the delegates enjoyed the dinner dance of the Section during the evening. Next morning at breakfast over 115 students and older engineers met. Each student was introduced. Then E. N. Noyes, speaking for the committee judging the prize papers, announced the award of the first prize of $25 to Tom Crist of Southern Methodist University; second prize of $15 to John R. West of the Agricultural and Mechanical College of Texas; and third prize of $10 to Burleson Graham of Texas University. Honorable mention was made to Martin Kuykendall of Texas Technological College and to J. R. Sims of Rice Institute, bringing $7.50 to each of these students. It was reported that two Student Chapters from New Mexico were interested in joining the Texas Student Chapter Conference. Talks were given by Deans Taylor and Gilchrist, as well as by Secretary Seabury.

After the Texas Section members adjourned to their own meeting, the students continued their session with discussion and election of officers for the coming year.

Discussion Invited on Concrete Report

AFTER INTENSIVE deliberation, the Joint Committee on Specifications for Concrete and Reinforced Concrete has evolved its report, as recently published by the various cooperating organizations—among them the Society, in the JUNE PROCEEDINGS, Part 2, as announced elsewhere in this issue.

Inasmuch as this report appears in PROCEEDINGS rather than in TRANSACTIONS, it is open to discussion the same as all other material thus published by the Society. The Committee on Publications, in such cases, reserves the right to publish discussion in subsequent issues of PROCEEDINGS or to transmit the material directly to the generating committee, for its information and future guidance. It is anticipated that all discussion of the Joint Concrete Report will be published except that which may be considered outside the proper scope.

What is desired, as in all such discussion in PROCEEDINGS, is comment directed toward the contentions of the committee report—as to what parts are valid, what may be in question, and what additional facts may be adduced to substantiate or invalidate the report. It can hardly be said that the whole subject of concrete is thus under discussion; but nevertheless, since the report is very broad, the discussion may cover the same wide range of subject matter, always related, of course, to the views of the Joint Committee.

In this way it is hoped that much light will be thrown on this important matter, to the benefit not only of the Committee, which has now submitted its considered views, but also of the profession in general, which is desirous of evaluating the data on this old but ever new subject. The combination of report and discussion thereon should thus constitute a full presentation of modern ideas on accepted concrete practice.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies in 40 States

U.S. Rushes $5,000,000,000 Defense Program

Germany's startling successes with her new kind of mechanized warfare has during the past month awakened the United States to one of its periodic realizations that its defenses are entirely inadequate, with the result that rush legislation is currently being passed to provide nearly $5,000,000,000 to expand the personnel, equipment, and facilities of the Army and Navy, and the civil production facilities necessary to accomplish this task.

In justice to the present Administration the fact should be pointed out that it has been as liberal with the defense establishment as was consonant with public opinion, even to the point of incurring considerable criticism for the extent to which it has allocated emergency expenditures for military purposes. Responsibility for the present inadequacy must be laid, not to any group or class, but to public sentiment as a whole. In this neglect the United States is not alone, as is evidenced by the succession of European nations that have found themselves virtually helpless in the face of new methods of mechanized warfare, even though most of them were better prepared than is the United States at this time.

No one can state with authority, of course, that the totalitarian powers will be victorious over Great Britain and France or that, in such an event, they will attack this country. But events of the past few months have repeatedly demonstrated the fact that the desire to remain neutral is no insurance against invasion, and it is the essential business of any nation to prepare itself to meet possible contingencies, even though they may be considered remote.

The current preparedness drive was initiated by a message to Congress delivered personally by President Roosevelt on May 16, in which he asked for the immediate appropriation of $896,000,000, in addition to contract authorizations to be met from later appropriations of $286,000,000, for the expansion of the Army, Navy, and Marine Corps. As reports from Europe became more and more serious these amounts were subsequently stepped up until they reached a total of $4,672,011,352, with no assurance that the end is in sight. This is equivalent to three-quarters of the amount spent for military purposes by this country during the first fiscal year of the World War.

The complexities and ramifications of the proposed program are too complex to be presented here in detail. Among the more significant items are the procurement of full equipment for an army of 1,000,000 men, as compared with a present strength of 230,000; major increases in the number of vessels and personnel of the Navy, and expansion of the air forces. In addition, it is desired to step up facilities for aircraft manufacture to a potential capacity of 50,000 planes per year, as compared with present estimates of 12,000 and to train large numbers of pilots and mechanics. Included in the Army equipment orders will be large quantities of mechanized units, including tanks, trucks, anti-aircraft and anti-tank guns, fire control equipment, and similar material. Also planned are many new air bases, training stations, and other facilities to care for the increases in personnel and equipment.

To finance these large expenditures Congress has under consideration measures to expand the present debt limit of the government and to increase taxes. Details are still unsettled, but it appears probable that income tax rates will be increased to the order of 10%, income tax exemptions may be lowered, and excise taxes on many items such as liquor, tobacco, gasoline, and other commodities may be increased.

Economic Effects

A program on so large a scale, requiring the adjustment of private industry to many entirely new products, is sure to have innumerable repercussions. In some lines of industry these will be minor, while in others large problems will arise. Perhaps the three fields most directly affected are the aviation, shipbuilding, and machine tool industries, already strained to capacity and now facing the need to step up production even more. All three face the immediate necessity of greatly expanding plant capacity and personnel.

Steps already taken in the aviation industry serve to illustrate the complexity of the problems involved. Already hard at work on rush orders for military aircraft for foreign buyers, this group faces the necessity of quickly expanding its rate of production from the present level of 12,000 planes per year to a new goal of 50,000. Leaders of the industry have already been called to Washington to discuss ways and means.

Such new plants as are necessary will be built, with the government evidencing a strong desire to have them located between the Allegheny and Rocky mountains, so as to be protected from attack. Government aid in financing expansion will be made available, either through the Reconstruction Finance Corporation or otherwise. In order to make the most effective use of existing plants, steps have already been initiated to pool American patents and to acquire those held abroad—the government, for example, has received a license to manufacture the Rolls Royce 12-cylinder liquid-cooled motor used in Britain's fastest ships.

Studies are under way leading to the standardization of orders in a few selected types of planes, each of which will be manufactured in a number of factories. The same procedure will be followed in stepping up airplane motor production, currently the "bottle-neck" in military plane output. A committee has been formed to study available types and select those which will be adopted.

Consideration is being given to converting some of the surplus automobile manufacturing capacity to airplane motors. A shortage of tool- and die-makers is anticipated and if it develops the auto manufacturers may be asked to forego their usual annual practice of announcing new models for 1942 (1941 model changes are already well advanced and will not be interfered with). Glenn L. Martin estimates that it now requires from 350 to 400 man-hours to produce a small plane, and the amazing total of 14,000 man-hours to turn out a large bomber, as compared with 218 hours for the standard low-priced motor car. Studies are being made to adopt more mass-production methods and cut down this labor requirement.

Defense Board Appointed

The number and magnitude of the problems that must be solved to render the defense program a reality prompted President Roosevelt on May 28 to create a commission of seven members to plan and coordinate the efforts of the many participants who must take part in this effort. The members, and their respective responsibilities, are:

Edward R. Stettinius, Jr., who resigned as chairman of the board of the United States Steel Corporation to supervise the orderly production and delivery of needed raw materials.

William S. Knudson, given a leave of absence from his position as president of General Motors to direct industrial manufacture.

Sidney Hillman, president of the Amalgamated Clothing Workers Union, placed in charge of personnel problems, including the training of additional workers.

Chester C. Davis, member of the Federal Reserve Board, to take care of problems relating to agriculture.

Ralph Budd, M. Am. Soc. C.E., chairman of the Chicago, Burlington & Quincy Railroad, to coordinate transportation and secure prompt delivery of raw materials and finished goods.

Leon Henderson, member of the Securities and Exchange Commission, to keep a check on industrial price trends, particularly as regards raw materials.

Miss Harriet Elliott, dean of women, University of North Carolina, to protect consumers.

While no specific authority was granted to this board to enforce its decisions and policies, the President is clearly determined to give it any necessary backing in preventing the defense program from becoming a mad scramble and causing unnecessary economic disruptions.

Effects on Labor

Statements of the C. I. O., and the A. F. of L., and the Bureau of Labor Statistics agree on the conclusion that an adequate supply of skilled labor is available, although some shortages will undoubtedly occur in specific localities. The U.S. Employment Office is already taking steps to transfer workers from points where there is a surplus to meet such conditions.

Many government officials, however, anticipate shortages in certain trades and a plan has been proposed for training courses to enrol a million young men from the NYA, CCC, and civilian life

for non-combatant service. The Civil Aeronautics Authority is proceeding with a program to start July 1 for the enrolment of 50,000 young men in primary flying courses, as well as several thousands of others with aviation experience to take advanced courses. Because of the high standards of military aviation, it is estimated that only 10% of these will become suitable for combat flying. To maintain a fleet of 50,000 planes is estimated to require from 100,000 to 150,000 expert pilots, in addition to 500,000 ground personnel, the majority of which must be highly trained technicians. The Army now has only 3,700 active and 2,000 reserve pilots; the Navy, while not announcing the number of its pilots, has a total air personnel of less than 5,000. The Navy's shipbuilding program alone will give employment to 50,000 men in addition to those currently working in yards. Altogether, it is clear that many new and expanded avenues for employment will be opened up by the preparedness program.

OTHER ANGLES OF THE PROGRAM

Among the many new developments springing from this sudden activity may be mentioned the decision of the Civil Service Commission to go on a 24-hour basis in order to meet promptly the calls for additional personnel; the reversal by the House of Representatives of its previous decision to postpone the construction of a third set of locks for the Panama Canal; the announcement by the Federal Works Agency that its personnel records of furloughed engineers will be made available to private employers needing such help to speed up production; and the transmission by President Roosevelt of Reorganization Plan V, transferring the Immigration Service from the Department of Labor to that of Justice.

A.E.C. STAGES TRANSPORT FORUM FOR A.I.E.E.

In response to an invitation from the Program Committee of the American Institute of Electrical Engineers, a forum on the topic, "Transportation as a Social Problem," is being held June 27 at Swampscott, Mass., as a morning session of the annual meeting of the Institute. Scheduled speakers are Col. William J. Wilgus, Hon. M. Am. Soc. C.E., formerly vice-president and chief engineer in charge of New York terminal improvements of the New York Central Railroad, and Col. Robert S. Henry, assistant to the president of the Association of American Railroads. In accordance with the usual forum pattern, the presentations of these gentlemen will evoke discussion from those attending.

Invitations to the forum were sent to engineering organizations within a reasonable distance of Swampscott, as well as to all persons now or formerly directly associated with Council's activities.

It is hoped that the success of this forum will lead to the inclusion of similar programs at the meetings of other national societies supporting the work of American Engineering Council.

PAN-AMERICAN INDUSTRIAL POSSIBILITIES STUDIED

Formation of an international commission to work toward closer economic collaboration among nations in the Western Hemisphere has been completed, and the first meeting was held in Washington early in June. Its purpose, working through committees of technical experts in each of the countries, is to survey the natural resources available and to point out where, in its opinion, opportunities exist for the investment of capital and the development of new industries with reasonable security for the investor.

Particular attention will be given to the promotion of lines for which there are available markets within the hemisphere, and it is hoped in this way to develop supplementary sources of strategic materials for which the countries concerned are now dependent upon areas of supply subject to interruption in war time. It is pointed out, for example, that Bolivia has large tin deposits and Brazil has already started to promote the production of rubber; both of which are now furnished to American markets predominantly by Asiatic suppliers.

Members of the commission, which was authorized at the conference of 21 American republics at Panama shortly after the outbreak of the European war, are: Edward J. Noble, U.S. Undersecretary of Commerce; Rafael Creamuno, former minister to the United States from Costa Rica; George W. Magalhaes, Westinghouse Electric and Manufacturing International Company; Renato Azeveda, managing director of Lloyd Brasileiro, Brazilian steamship operators; and Charles Campbell, commercial counselor of the Chilean Embassy in Washington.

Washington, D.C.
June 6, 1940

Junior Forum in District of Columbia

AMONG OTHER Junior Forums that are doing good work for the Society is that in the District of Columbia. Its objects, as detailed in a recent letter sent to all Juniors of the Washington Section, are as follows:

"To promote professional and social fellowship among Juniors of the Section.

"To give the Juniors an opportunity to discuss matters of particular interest to young engineers.

"To afford opportunity for practice in the preparation of papers and presentation of talks.

"To give Juniors an opportunity for greater activity in Society affairs."

This program, as the Forum states, is designed to contribute to the Juniors' professional growth and development. In line with similar successes in other places, such efforts should indeed prove beneficial to these younger members.

News of Local Sections

Scheduled Meetings

INDIANA SECTION—Annual all-day picnic at the Ross Camp, Purdue University School of Civil Engineering, on July 14.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Wednesday at 12:10 p.m.

SAN FRANCISCO SECTION—Dinner meeting of the Junior Forum at the Engineers' Club on July 23, at 5:45 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Knoxville Sub-Section at the S & W Cafeteria on July 9, at 5:45 p.m.

Recent Activities

ARIZONA SECTION—*Tucson, April 27:* A business session in the morning inaugurated the all-day annual meeting of the Section. There was considerable discussion on the subject of competitive bidding for engineering services at this session, and a resolution advocating the protection of state municipalities and public agencies from poor professional engineering services was passed. At the same meeting the Section passed another resolution urging the Arizona State Highway Commission to adopt immediately and make effective July 1 a new set of highway workers' classifications and salary schedules. Following a joint luncheon with the Tucson Engineers' Club, there was a technical session. During the evening meeting the Section presented its annual award of Junior membership in the Society to Harry Aloysius Kotecki.

CENTRAL OHIO SECTION—*Columbus, May 24:* Joint dinner meeting with the Ohio State University Student Chapter. Director Root was present and gave a short talk on the opportunities for work in the Student Chapters, Local Sections, and the Society. President Jennings then presented the Section prize of Junior membership in the Society to Charles Harold Kruse, of Ohio State University. The principal speaker on the technical program was M. Y. Poling, director of the Engineering Surveys Section of the WPA, Washington, D.C., who gave an illustrated lecture on the development and use of geodetic control.

CLEVELAND SECTION—*April 8:* A talk on the subject, "Raw Materials and War," was the feature of the regular monthly luncheon meeting. This was given by C. Langdon White, head of the department of geography and geology at Western Reserve University. *May 10:* Annual joint dinner meeting with the Student Chapters at Akron University, Ohio Northern University, and the Case School of Applied Science. The list of speakers included members of the staff at these universities and James H. Herron, consulting engineer of Cleveland. The Section's annual prizes of Junior membership in the Society went to Robert Ash, of Ohio Northern University; Ersel Lantz, of Akron University; and B. E. Mansell, of the Case School. Another student at Case—F. P. Converse, Jr.—was also awarded Junior membership in the Society. The latter award, which was sponsored by the civil engineering department at Case, was a special feature and not to be construed as a precedent. A number of students then discussed their thesis

projects, the list including R. L. Wood, W. L. Rau, Jr., W. G. Hamlin, F. P. Converse, Jr., B. E. Mansell, and D. A. Dreifort, all of the Case School; and Ersel Lantz, of Akron University.

COLORADO SECTION—*Denver, May 13:* The feature of the occasion was a talk by C. P. Vetter, designing engineer for the U.S. Bureau of Reclamation, who spoke on the subject, "The Engineering Student and the Engineer." During the evening it was announced that the Section's prizes of Junior membership in the Society go to Leonard P. Zick, of Colorado State College, for his paper entitled "Ethics of the Young Engineer"; and to Clara Barnes, of the University of Colorado, for her paper on "Prefabrication in the Building Industry."

DAYTON SECTION—*May 20:* Annual joint meeting with the University of Dayton Student Chapter, with the Chapter acting as host. The principal speaker was Joseph Dolan who, from the vantage point of thirteen years spent in Europe, discussed "Present-Day Europe as Seen by a Civil Engineer." Motion pictures of the Dayton-St. Mary's game played last year on the West Coast concluded the evening.

DISTRICT OF COLUMBIA SECTION—*June 8:* Members of the Section visited the Rock Creek Diversion Sewer and the Washington National Airport at Gravelly Point, Va. At the first of these projects Ellwood Johnson, resident engineer, explained the plan that is being followed in the construction of the sewer, comprising about six miles of tunnel and cut-and-cover sections. At the airport Col. Robert S. Thomas, district engineer for the U.S. War Department, conducted the guests about the landing field and displayed the operation of one of the largest asphalt-mixing plants that has thus far been built.

DULUTH SECTION—*April 15:* Kodachrome still and motion pictures of Mexico were shown by Elbert H. Dresser, who had just returned from a vacation trip to Mexico. Mr. Dresser is chief engineer for the Duluth, Missabe and Iron Range Railway.

FLORIDA SECTION—*Jacksonville, May 14:* Joint meeting with the Northeast Florida Association of Registered Professional Engineers and Land Surveyors. There was considerable discussion of the feasibility of combining the Engineers' Registration Law and the Land Surveyors' Law, and the joint session went on record as favoring the combining of the laws. A motion picture, entitled "The Making and Shaping of Steel," was shown through the courtesy of Clarence H. Moore, of the Aetna Iron and Steel Company.

GEORGIA SECTION—*Atlanta, May 13:* Members of the Section were guests of the Georgia School of Technology Student Chapter. The technical program consisted of the reading of papers by two students—Rufus Morgan and Howard Porter. Mr. Morgan's paper, which was on the Atlanta sewerage system, had previously won a prize in the Southeastern Student Chapter Conference.

HAWAII SECTION—*Honolulu, April 16:* The speaker of the evening was Joseph F. Kunesh, director of the Territorial Planning Commission, who discussed the subject, "Budgeting the Territorial Program." Distribution of the taxation dollar of the Territory of Hawaii was portrayed in diagrams and compared to that for the United States as a whole.

ILLINOIS SECTION—*Chicago, April 12:* Following a luncheon, W. G. Arn and Arthur Consoer spoke. Colonel Arn summarized a proposed bill for the registration of professional engineers in Illinois, while Mr. Consoer explained the Alexander Bill now being considered by the House of Representatives. *May 3:* There were two sessions on this date—a luncheon in honor of the recipients of the Section's awards of Junior membership in the Society and a dinner meeting in the evening held jointly with the Midwest Conference of Student Chapters. Field Secretary Jessup was present on both occasions and addressed the dinner meeting on the subject of engineering ethics. The technical program on the latter occasion consisted of a talk by Loran D. Gayton, city engineer of Chicago, who spoke on "Underground Chicago." *May 14:* Joint meeting with the hydraulics, sanitary, and municipal sections of the Western Society of Engineers. The guest of honor and speaker was the Hon. Edward J. Kelly, mayor of the city of Chicago, who discussed "What's Ahead for Engineering in Chicago."

IOWA SECTION—*May 21:* An illustrated lecture on the Lake Washington (Seattle) Pontoon Bridge and the Narrows Bridge at Tacoma was given by H. B. McMinn, highway bridge engineer for the Public Roads Administration at Portland, Ore. *Ames, June 3:* The technical program consisted of a description (illustrated with colored slides) of a year's graduate work at the Yale Traffic School, given by W. W. Davis, and a talk on the "Design of Concrete Pavements" by E. F. Kelly. The latter is chief of the Department of Tests of the U.S. Public Roads Administration, and Mr. Davis is traffic engineer for the Iowa State Highway Commission.

ITHACA SECTION—*Binghamton, N.Y., April 16:* Joint meeting with the Broome Area Chapter of the New York State Society of Professional Engineers. The feature of the occasion was a talk on "Aviation in Peace and War," given by Lauren D. Lyman, assistant to the president of United Aircraft. *Elmira, N.Y., May 21:* George J. Nold, major, Corps of Engineers, U.S. Army, presented an illustrated lecture on "Military Engineering." The Section announces that the 1940 recipient of Junior membership in the Society is William Arthur Gay, of Cornell University.

KANSAS STATE SECTION—*Topeka, May 17:* The technical program consisted of talks by LeRoy Johnson and C. S. Carr, of the Topeka Flying Service, who discussed the C.A.A. College student training program and showed a motion picture of acrobatic flying. Awards of Junior membership in the Society were presented to George Willits Vaught, of Kansas State College, and Dwight Metzler, of the University of Kansas.

KENTUCKY SECTION—*Lexington, May 17:* Joint dinner meeting with the Student Chapters at the University of Louisville and the University of Kentucky, the latter Chapter acting as host. The program consisted of papers presented in a prize contest by the following students: C. S. Rankin, J. W. Sheppard, H. C. Young, T. C. Finnie, H. C. Hickerson, and H. J. Weaks. The first prize of $15 went to Mr. Hickerson, second prize of $10 to Mr. Weaks, and third prize of $5 to Mr. Finnie. During the evening the Section's awards of Junior membership in the Society were also presented, the recipients being D. K. Blythe, of the University of Kentucky, and J. W. Sheppard, of the University of Louisville. Director J. E. Root concluded the meeting with a short talk on the opportunities for work in the Society.

LEHIGH VALLEY SECTION—*Bethlehem, Pa., May 13:* Members of the Student Chapters at Lehigh University and Lafayette College were guests of the Section on this occasion. The speakers were H. S. Mattimore, engineer of tests for the Pennsylvania State Highway Department, and Field Secretary Jessup.

LOS ANGELES SECTION—*Pasadena, May 8*: Following its annual custom, the California Institute of Technology Student Chapter entertained the members of the Section for its May meeting. A tour of the campus and inspection of the grinding of the 200-in. lens for the Palomar Observatory preceded a dinner in the Athenaeum. The technical program, presented later in the evening, included talks by Dr. Joseph J. Johnson, research fellow in astrophysics; E. J. Poitras, control engineer on the telescope project; and Dr. John A. Anderson, executive officer of the Observatory Council.

MARYLAND SECTION—*Baltimore, May 7:* It was announced that the Section's awards of Junior membership in the Society go to William S. McKay, of Johns Hopkins University, and Edward K. Bebb, of the University of Maryland. The meeting was then turned over to the Student Chapter members, who presented three speakers—William Corkran, of the University of Maryland; Edward Wenk, Jr., of Johns Hopkins University; and Charles R. Parsons, of the University of Maryland. *May 28:* Following a business meeting, two official sound motion pictures on "Attack Aviation" and "Combat Vehicles of the Mechanized Cavalry" were shown through the courtesy of the U.S. War Department.

METROPOLITAN SECTION—*May 15:* A paper on "An Engineer's Approach to an Industrial Problem"—presented by W. H. Coverdale, New York City consulting engineer—comprised the technical program. A special feature of the occasion was the Annual Effective Speaking Contests for the William F. Reeves Memorial Prizes, which was conducted by the Junior Branch. The first prize of $15 went to L. F. Granger for his address on "Organizing for Steady Employment," and the second prize of $10 to M. L. Cohn whose talk was entitled "One-Third of the Nation." Certificates of honorable mention were then presented to Morris Atkin and A. N. Carter. The next item on the program was the award of the Robert Ridgway Student Chapter Prize to the outstanding senior in each

of the eight Student Chapters in the Metropolitan district. These prizes, covering the first year's expenses incidental to membership in the Society and the Section and the Junior badge, go to Joel Wiesenfeld, College of the City of New York; Carlos A. Bejarano, Columbia University; Michael T. Aquino, Cooper Union; Frank T. Griffin, Manhattan College; Peter Homac, Newark College of Engineering; Henry W. Fischer, New York University; Robert H. Cummings, Polytechnic Institute of Brooklyn; and William P. Comstock, Rutgers University. During the annual business meeting Enoch R. Needles was elected president, and Thorndike Saville, vice-president. Charles E. Trout will continue as treasurer, and Col. William J. Shea as secretary.

MOHAWK-HUDSON SECTION—*Troy, N.Y., May 7:* This meeting took place at Rensselaer Polytechnic Institute, and the program consisted of a series of demonstrations in the laboratories of the civil engineering building, the demonstrations being conducted by Juniors and Student Chapter members of the Society. In the materials testing laboratory a welded beam-to-column connection was tested to destruction, and in the photogrammetry laboratory the method of producing maps from aerial photographs using the principle of radial line plotting was demonstrated.

NASHVILLE SECTION—*May 22:* The regular bimonthly meeting, which was to have taken place in June, was advanced a few weeks in order to accommodate a student paper contest. The contestants, all of whom chose their subjects from the last volume of TRANSACTIONS, were Myers Algood, Ralph Carter, Bob Downing, Martin Freeland, and James Norris. The first prize of $10 went to Mr. Downing; second prize of $7.50 to Mr. Norris; and third prize of $5 to Mr. Freeland.

OKLAHOMA SECTION—*Norman and Oklahoma City, April 23:* Joint meeting with the University of Oklahoma Student Chapter at Norman in the afternoon in honor of President Hogan, Secretary Seabury, and Director Robert B. Brooks. The same group attended an evening meeting in Oklahoma City. *Stillwater, April 24:* Joint meeting with the Oklahoma Agricultural and Mechanical College Student Chapter, with President Hogan and Secretary Seabury as guests of honor.

OREGON SECTION—*Portland, June 3:* Members of the Oregon State College Student Chapter were guests of the Section. The feature of the occasion was the presentation of the two prize-winning papers in the student contest for Junior membership in the Society. Joseph A. Havenner read his paper on "An Analysis of the Street Parking Facilities of Corvallis, Oregon," and Jerry Cavanagh his on "The Effect of the Angle of Approach on Orifice Coefficients."

PHILADELPHIA SECTION—*May 11:* A symposium on foundations was the feature of the occasion, the main paper being presented by Frank N. Kneas, consulting engineer of Philadelphia, who discussed the subject from the engineer's viewpoint. Other papers were presented by J. R. Burkey, consulting engineer to the Union Metal Manufacturing Company, who described the Monotube Pile and its uses; and G. G. Greulich, of the Carnegie-Illinois Steel Corporation, whose subject was "Steel Bearing Piles." Then Julius Adler, consulting engineer of Philadelphia, showed colored moving pictures of specially designed forms used in the construction of small homes. There was also a film (shown by Alexander Foster, Jr., vice-president of the Warner Company) depicting the use of ready-mixed concrete on varied construction jobs.

PITTSBURGH SECTION—*April 12:* A special smoker was arranged in honor of President Hogan, who addressed the gathering. *May 8:* The program on this occasion was in the hands of the Junior Division, which presented three papers—"Valuation Engineering" by Alfred Crew III, junior engineer for Morris Knowles, Inc.; "Geophysical Prospecting" by J. E. Backman, of the Gulf Research and Development Company; and "Operation of Tygart Dam," by R. M. Morris, of the U.S. Engineer Department. The annual awards of Junior membership in the Society went to William J. Dixon, of the Carnegie Institute of Technology, and Robert K. Schrader, of the University of Pittsburgh. During the annual business meeting Louis P. Blum was elected president for the ensuing year, and Daniel E. Davis, vice-president. C. B. Stanton will continue as secretary-treasurer.

PROVIDENCE SECTION—*June 3:* The main speaker on the program was Lt. Col. Clark S. Robinson, of the Ordnance Reserve, who discussed "Industrial Preparedness," and showed two reels of moving pictures—one on "Mechanized Cavalry" and the other on "Ordnance Day at the Aberdeen Proving Grounds." The list of guests, invited to celebrate the twentieth anniversary of the founding of the Section, included Director C. M. Blair, officers of the Northeastern Section, and several students. During the business meeting Frank W. Stubbs, Jr., was elected chairman for the coming year; H. A. Whitcomb, vice-chairman; and F. H. Paulson, secretary-treasurer.

ROCHESTER SECTION—*May 9:* Joint meeting with the Rochester branch of the American Society of Mechanical Engineers and the Rochester Engineering Society, preceded by a business session of the Section. The principal speaker was Frank P. Cartwright, engineer and distributor for Timber Connector Construction, who gave an illustrated lecture on "Modern Timber Design."

ST. LOUIS SECTION—*May 10:* On this occasion members of the Section were guests of the Washington University Student Chapter at a dinner meeting. The technical program consisted of talks by members of the senior class at the university, each of whom gave a brief report on his thesis work. Several members of the faculty also spoke, the list including Prof. W. W. Horner. Inspection of the various laboratories, where the work in progress was demonstrated, concluded the meeting. The Section announces that this year's awards of Junior membership in the Society go to Harold B. Lockett, of Washington University; and Robert N. Lorrance, of the Missouri School of Mines and Metallurgy.

SACRAMENTO SECTION—*May 14, 21, and 28:* The speakers at these regular weekly luncheon meetings were R. L. Jones, deputy state engineer in charge of flood control and reclamation; Gordon L. Williams, assistant engineer for the U.S. Bureau of Reclamation; and M. A. Johnston, instructor in public speaking at the Sacramento Junior College. *Junior Forum, May 8:* On this occasion Otto H. Meyer, assistant engineer in the U.S. Engineer Office at Sacramento, spoke on the subject, "Routing the 1940 Sacramento River Flood."

SAN DIEGO SECTION—*April 25 and May 23:* The speaker at the first of these sessions was Charles T. Leeds, Director of the Society, who gave an illustrated lecture on "Beach Erosion and Storm Control." At the May meeting R. B. Hood, special agent in San Diego for the Federal Bureau of Investigation, spoke on "Science and Crime."

SEATTLE SECTION—*May 21:* Joint meeting with the Tacoma Section. A large attendance turned out to hear R. B. Van Horn, professor of hydraulic engineering at the University of Washington, and Alvin B. Darland, field engineer for the U.S. Bureau of Reclamation. Professor Van Horn's subject was the development of the Columbia Basin Project, while Mr. Darland gave an illustrated talk on the Grand Coulee Dam Project.

TACOMA SECTION—*April 27 and May 21:* The first of these sessions was a joint meeting with the Northwest Regional Conference on Student Chapters. The group met in the afternoon for an inspection trip to the Tacoma Narrows Bridge and to the McChord Flying Field. Following a dinner in the evening, Henry Foss showed colored motion pictures of the Tacoma Narrows Bridge, while Clark H. Eldridge, engineer for the Washington Toll Bridge Authority, explained the project. The May meeting was the joint session with the Seattle Section previously described in this department.

TOLEDO SECTION—*May 10:* Following a dinner and brief business session, W. W. De Berard, Director of the Society, reported on the doings of the Board at both the Annual and Spring Meetings of the Society, discussing particularly the changes necessitated by the increase in Junior membership.

UTAH SECTION—*Junior Forum, Salt Lake City, May 24:* The list of guests included local high school graduates, who are hoping to pursue an engineering education, and members of the Student Chapter at the University of Utah. A symposium on "Vocational Guidance of the Young Engineer" was the feature of the occasion, and nine books covering different phases of the subject were reviewed by young men in the Forum. A group of five-minute papers was then presented by other members of the Forum—Arthur Lanzenby, John Duder, Grant Borg, Foster Kunz, Blaine Watts, Clifford Stevenson, Ellis Armstrong, and Elmo Morgan—all of whom discussed their practical engineering experiences since graduation.

ITEMS OF INTEREST

About Engineers and Engineering

CIVIL ENGINEERING for August

"PROBABLY in no field of heavy construction has greater progress been made during the last 10 to 15 years than in excavating, transporting, and placing the materials for earth dams," says O. N. Floyd, whose paper for the August issue of CIVIL ENGINEERING is devoted to that subject. A discussion of the relative economics of rolled fill and hydraulic fill, descriptions of operations at three recent projects, and data on cost and equipment performance make up this important contribution.

For those interested in hydraulics, articles of two widely different types are included. New developments in the technique of creating and maintaining a navigable channel in the Missouri River are described by D. R. Neff, while a rather extensive laboratory research project on the discharge of overflow spillways with various face angles and varying degrees of submergence is reported by A. S. Offitzeroff.

Interesting accounts of bridge engineering in both concrete and steel are also scheduled. Everett Scroggie describes the planning and reconstruction work on a concrete girder bridge which was raised, split longitudinally, and widened to accommodate a new grade and heavier traffic over an arm of the Chickamauga Reservoir. By contrast, Morris Goodkind covers design problems for the new Thomas A. Edison Bridge at South Amboy, N.J. This is a long and large fixed steel structure at high level including the longest and biggest plate girders yet built in the United States.

The remainder of the issue will consist largely of papers from Society meeting programs. Among these are R. H. Gould's concluding article in the series on sewage disposal problems of the New York area, A. H. Riney and Stanley Learned's paper on gasoline pipe lines, "the baby of the pipe-line family," and R. B. Wills' account of low-cost road building in Kansas.

United States Hydrology

THE FOURTH ANNUAL edition of the *Bibliography of Hydrology* prepared by members of the American Geophysical Union, many of them also members of the Society, has just been issued. This bibliography covers as completely as possible all publications in the field of hydrology issued in 1939 in the United States, including government publications, and contains abstracts of all references.

The United States Bibliography of Hydrology was originally established in cooperation with the International Association of Scientific Hydrology, with headquarters in Paris, France, in its effort to publish an annual world bibliography. This year the United States alone of all the countries represented in the International Association is in a position to continue the work with undiminished vigor. The financial aid of the International Association has been withdrawn on account of present world conditions, but the American Geophysical Union will continue this publication on a self-supporting basis in view of the very rapid progress being made in hydrology and the need for prompt dissemination of data and research in this field.

Abstracts are prepared under the supervision of chairmen of the research committees of the Section of Hydrology of the American Geophysical Union, which is organized to function in the following specialized fields: Rainfall and Hydrometeorology, Runoff and Floods, Underground Waters, Snow, Glaciers, Physical Limnology, Evaporation and Transpiration, Infiltration, Physics of Soil Moisture, Dynamics of Streams, and Chemistry of Natural Waters.

The bibliography contains some 400 entries. Society members may subscribe by making an advance payment of 50 cents per copy to the American Geophysical Union, 5241 Broad Branch Road, N.W., Washington, D.C.

Prof. N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

THE PROFESSOR didn't have us guessing very long last month when he asked the members of the Engineers Club to guess the arrangement of numerals on the sun dial mounted on top of the North Pole, having given us the clue that the sum of the 24 numerals was 288.

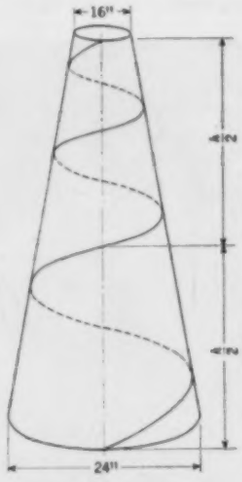
Since two rounds of the numbers 1 to 12 inclusive would have aggregated only 156, we "second-guessed" a series of 1 to 24 inclusive. But that series added to 300. Somehow there had to be a reduction of 12.

Then a bright idea—the numeral 12 was replaced or covered by the Los Angeles official seal. "But there were 24 numerals," reminded Professor Neare. The fourth guess sounded more desperate than logical—the series $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$ . . . $23\frac{1}{2}$; here, at least, were 24 numerals that added right, and nothing had been said of integers. "Clever, but not even warm," was the verdict.

"All 12's," piped up one of our bright Juniors, who knew his multiplication tables up to 99 × 99.

"Right, on the last guess, as usual," echoed the Professor. "At the Pole, the sun is always to the south, always on the meridian. Therefore, the sun time at the Pole is always 12 o'clock noon. Of course the Pole is only a geometric point at the style; elsewhere on the tablet the time varies. But where the shadow falls on the dial, the time must be 12 o'clock midnight.

"Mr. Nipp described one other detail that may interest you—at least it kept me out of mischief for over an hour. The tablet was mounted on a simple sturdy pedestal in the shape of a right truncated cone, but the simplicity was blended with a bit of magic, so to speak. If a funicular line were to be drawn on the pedestal by fastening one end of a string to the top of the pedestal and the other end to the base so that the string be taut and make exactly three turns about the conical surface of the pedestal, then exactly two of those turns would be complete above mid-height. Incidentally a design scribed on the shaft depends upon helicoidal stripes following such funicular lines.



"Nipp also observed that the diameter of the pedestal was 24 in. at the base and 16 in. at the top, from which I was able to compute the height of the pedestal. I recommend the problem as an intriguing exercise. But note well that the taut string must fall on the shortest superficial path, which path may not be uniformly inclined."

Members Awarded Honorary Degrees

EACH year at commencement time honorary degrees are awarded certain engineers who have made notable contributions to the profession. Word of several members of the Society thus honored has already reached Society Headquarters, and the list of these follows. Doubtless there are others of whom the Society has not yet heard.

HERSCHEL H. ALLEN, Doctor of Engineering, University of Maryland.

EDUARDO JUSTO CHIBAS, Doctor of Engineering, Rennsselaer Polytechnic Institute.

GANO DUNN, Doctor of Science, New York University.

FREDERICK W. GREEN, Doctor of Engineering, Missouri School of Mines and Metallurgy.

JOHN P. HOGAN, Doctor of Engineering, New York University.

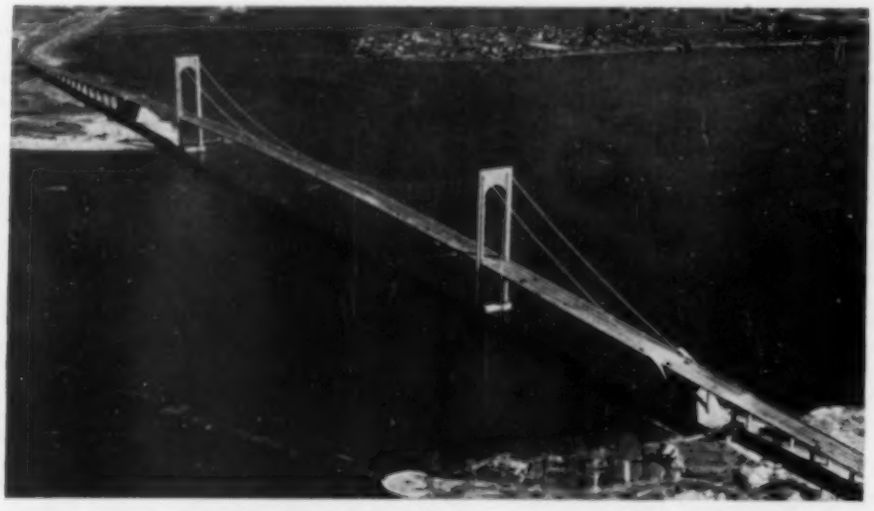
WILLIAM OTIS HOTCHKISS, Doctor of Science, Columbia University.

C. EARL WEBB, Doctor of Engineering, Michigan State College.

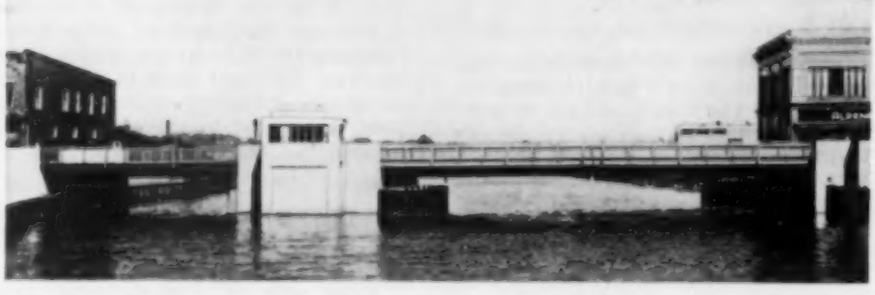
A.I.S.C. Awards for Artistic Steel Bridges

EACH YEAR the American Institute of Steel Construction, Inc., records its appreciation of beauty by making awards for the construction of steel bridges of artistic merit. In this competition there are four classifications: Class A, bridges costing $1,000,000 or more, Class B, those costing $250,000 or more, Class C, those costing under $250,000, and "the most beautiful movable bridge." The awards for structures built in 1939 have recently been announced.

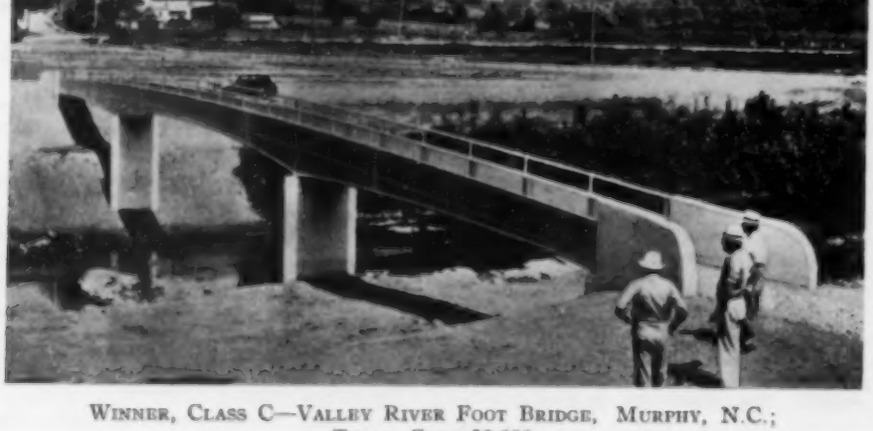
First place in Class A went to the Bronx-Whitestone Bridge across the East River, New York City, whose total cost was $10,000,000. The engineers were the Triborough Bridge Authority, with O. H. Ammann, chief engineer; Allston Dana, engineer of design; Leon S. Moisseiff, consulting engineer on design; Aymar Embury II, architect; Madigan-Hyland, consulting engineers on construction; and H. W. Hudson, engineer of construction. All men named are Society members.



WINNER, CLASS A—BRONX-WHITESTONE BRIDGE ACROSS EAST RIVER, NEW YORK CITY; TOTAL COST $10,000,000



WINNER IN MOVABLE BRIDGE CLASS—SECOND AVENUE BRIDGE, ALPENA, MICH.; TOTAL COST $289,000



WINNER, CLASS C—VALLEY RIVER FOOT BRIDGE, MURPHY, N.C.; TOTAL COST $6,000

Honorable mention in Class A went to the Highland Park Bridge, over the Allegheny River in Highland Park, Pittsburgh, Pa., which cost $2,409,126. Engineers were the Allegheny County Department of Works, with John F. Laboon, M. Am. Soc. C.E., director; Levi Bird Duff, chief engineer; Parsons, Klapp, Brinckerhoff and Douglas, advisory engineers; and Waddell and Hardesty, Members Am. Soc. C.E., as associate engineers.

In Class B no award was made but first honorable mention was given to the Howard Street Bridge in Baltimore, Md., which cost $936,000. The engineers were the J. E. Greiner Company. Second honorable mention in Class B went to the Grove Highway Bridge, near Grove, Okla. which cost $369,000. The bridge was designed by Victor H. Cochrane for Holway and Neuffer, engineers for the Grand River Dam Authority. All those mentioned are members of the Society.

First place in Class C went to the Valley River Foot Bridge at Murphy, N.C., which cost $6,000. The engineers were the Tennessee Valley Authority, with T. B. Parker, chief engineer; Harry A. Hageman, chief design engineer; F. W. Webster, head highway engineer; and Erwin Harsch, senior structural engineer—all members of the Society.

There were two honorable mentions in Class C. The Alton Railroad Overhead Bridge, on U.S. 66, at Mazonia, Ill., had a total cost of $146,147.79, and the engineers were Ernst Lieberman, Assoc. M. Am. Soc. C.E., chief highway engineer, and Alfred Benesch, engineer of grade separations. The Waverly Bridge, on the Ingham-Eaton County line, near Lansing, Mich., cost $78,050.17, and the engineers for it were J. G. Rakowsky, Ingham County Engineer (in charge), and F. A. McCowan, assistant engineer (design and inspection).

First place in the movable bridge class was awarded to the Second Avenue Bridge over Thunder Bay River, Alpena, Mich., costing $289,000. The engineer was Clifford E. Paine, M. Am. Soc. C.E.

Honorable mention in this class went to the Northwest 27th Avenue Bridge in Miami, Fla., over the Miami River. Its total cost was $388,152.44 and the engineers were Edmund Friedman, county engineer, Dade County, and Harrington and Cortelyou, consulting engineers, all members of the Society.

This is the twelfth consecutive year that these awards have been made. The prize-winning structures are decorated with stainless steel plaques designating them the most beautiful in their class constructed during the year.

Observatory Commemorates Family of Engineers

RECENTLY an interesting and valuable hobby of one family of engineers was again brought into the spotlight when a 70-ft tower telescope at the McMath-Hurlbert Observatory at Lake Angelus, Mich., was presented to the University of Michigan. This equipment is said to

place the observatory in an envious position among those specializing in solar research. The institution is in large measure a monument to the McMath family, prominent in engineering circles in Detroit for many years.

Going back still further, Robert E. McMath, a director of the Society in 1889, was a prominent engineer in St. Louis. His son, the late Francis C. McMath, M. Am. Soc. C.E., of Detroit, became interested in amateur astronomy in 1925. In turn his son, Robert C. McMath, M. Am. Soc. C.E., caught the enthusiasm, and together, with the assistance of Henry S. Hurlbert, they have developed this interesting project. The present added equipment is given by the McGregor Fund.

Other engineers have been greatly interested in astronomy although the present father-and-son team may be unique in this field. It is of interest that Dr. Robert C. McMath is the third generation enjoying the tradition of membership in the Society.

Brief Notes from Here and There

MEMBERS of the Society will be welcomed in Denver by the Colorado Society of Civil Engineers, which by recent action extends to them the privilege of using its office, employment service, or other facilities. All professional courtesies are reciprocated to its members by the Society. A complete list of organizations exchanging similar mutual privileges with the Society is given in the Year Book, on page 129.

* * * *

A STRUCTURAL Steel Welding Research Committee is being organized by the Welding Research Committee of the Engineering Foundation in cooperation with the American Institute of Steel Construction. Besides the establishment of fellowships, the committee will address itself to securing basic data for applying welding to building with greater safety and greater economy. Chairman of the committee is Leon S. Moisseiff, and other members include F. N. Frankland, Jonathan Jones, C. F. Goodrich, A. S. Low, C. A. Trexel, LaMotte Grover, and Bruce Johnston. All but Mr. Low are members of the Society.

* * * *

ANNOUNCEMENT IS made of a Conference in Traffic Engineering sponsored by the College of Engineering of the University of Texas, at Austin, Tex., July 15 to 20. Matters relating to accidents, speeds, channelization, signs, lighting, economics, and enforcement will be discussed. This conference is open to all public officials in the United States and Mexico.

* * * *

A SHORT SUMMER course in the "theory and application of photoelasticity" is to be conducted at the Massachusetts Institute of Technology from July 22 to August 2. Information may be obtained from the registrar or from Dr. William M. Murray, Room 1-321, at the Institute, Cambridge, Mass.

* * * *

FOLLOWING recommendation of the Permanent Committee on Simplification of Varieties of Vitrified Paving Brick at its April meeting, there is prospect of the addition of a standard 4-in. by $3^1/_2$-in. by $8^1/_2$-in. wire-cut lug brick to the list of recognized varieties. This increase from 4 to 5 in the standard sizes is made because of repeated demand for it in city street pavements in certain localities. Over 90% of the normal demand for paving brick is said to be covered by these standard sizes.

* * * *

A VARIETY of summer courses in city and regional planning is scheduled at the Massachusetts Institute of Technology between July 8 and July 26. Studies in City and Regional Planning, Techniques of Planning, Planning Administration, and Planning Legislation are listed. Inquiries may be addressed to Prof. Frederick J. Adams, at the Institute, Cambridge, Mass.

NEWS OF ENGINEERS

Personal Items About Society Members

GEORGE E. JEWETT, engineer for the Chicago Bridge and Iron Company, is being transferred from Chicago to the New York office of the company. RAY MENEFEE has been transferred from Chicago to the Cleveland office.

EDWARD H. HARRIS has resigned as junior engineer for the Hollingsworth and Whitney Company, of Mobile, Ala., to accept the position of resident engineer for the State Highway Board of Georgia at Rome, Ga.

R. G. WHEELDON, formerly senior engineering aide for the Kentucky State Highway Department, is now safety engineer for the Liberty Mutual Insurance Company, with headquarters in Louisville, Ky.

RICHARD L. TEMPLIN, chief engineer of tests for the Aluminum Company of America, has been awarded an Edward Longstreth medal by the Franklin Institute in recognition of his invention of a deformation-recording apparatus. The award was made in Philadelphia on May 15 by Dr. Henry Butler Allen, director of the Institute.

LESTER H. REYNOLDS has taken a position as project superintendent of the Jackson County (Kentucky) Rural Electric Cooperative, Inc., and is located at McKee, Ky. Until lately he was junior engineer trainee for the REA in Washington, D.C.

ALBERT J. KULLAS, JR., is terminating his connection with New York University, where he has been serving as graduate assistant in the civil engineering department, to accept a position with the Glenn L. Martin Company in Baltimore, Md.

H. HERSHEY MILLER, former chief materials engineer for the Pennsylvania Department of Highways, was recently appointed engineer of tests with the Pennsylvania Turnpike Commission.

HAROLD D. CAVIN has been engaged as consulting engineer by the Puget Sound Pulp and Timber Company at Bellingham, Wash. He was previously resident engineer for the Hardy S. Ferguson Company (of New York City) on the construction of a paper mill for the Hollingsworth and Whitney Company at Mobile, Ala.

E. S. BLAINE recently resigned as construction engineer for the Kansas City Bridge Company at Plaquemine, La., to accept a position as engineer for the Equitable Equipment Company at Madisonville, La.

WILSON V. BINGER is transferring from the U.S. Engineer Office at Wilmington, Del., where he was junior engineer, to the U.S. Waterways Experiment Station at Vicksburg, Miss., where he will serve in a similar capacity.

WENDELL P. BROWN, president and chief engineer of Wendell Brown and Associates, Cleveland, Ohio, was honored with a citation by the Cleveland Society of Professional Engineers on May 15. In making the citation the society presented Mr. Brown with a certificate honoring him for "distinguished engineering contribution to the public welfare, for engineering undertakings of high technical order in the design and construction of many notable bridges and viaducts, and for his contribution to the continued advancement of the engineering profession."

LOWELL J. STEPHENSON, formerly with the California Division of Highways on the construction of approaches to the San Francisco-Oakland Bay Bridge and the Golden Gate Bridge, has accepted the position of engineer for the American Dredging Company, which is engaged in dredging operations for the new Naval Air Station at Alameda, Calif.

PAUL L. REED and DE WITT C. WEBB, captains, Civil Engineer Corps, U.S. Navy, have been ordered to report for active duty at the Bureau of Yards and Docks of the Navy Department at Honolulu, Hawaii. ALGERT D. ALEXIS, lieutenant-commander, Civil Engineer Corps, U.S. Navy, has been transferred from the Sixth Naval District to duty in the Twelfth Naval District at San Francisco, Calif.

ISAAC DE YOUNG, for many years senior engineer and general superintendent of the St. Marys Falls Canal for the U.S. Engineer Office, with headquarters at Sault Ste. Marie, Mich., has announced that he will retire from active service in August.

ALBERT K. B. LYMAN, colonel, Corps of Engineers, U.S. Army, has been transferred to Hawaii from Boston, where he was head of the U.S. Engineer Office.

FRANK C. TYRRELL and JULIAN W. SILLIMAN, of the Civil Engineer Corps, U.S.

Naval Reserve, have been ordered to report for temporary active duty—Lieutenant Tyrrell at the Bureau of Yards and Docks in Washington, D.C., and Lieutenant Silliman at the Naval Training Station, Newport, R.I.

PAUL W. PURDOM is now sanitary engineer for the Colquitt County (Georgia) Health Department, with headquarters in Moultrie, Ga.

PATRICK QUILTY, for the past three and a half years acting chief engineer of the New York City Department of Water Supply, Gas and Electricity, has been appointed chief engineer of the department. Mr. Quilty has been in the employ of the city for thirty-six years.

CECIL J. ESPY, JR., lieutenant (jg), Civil Engineer Corps, U.S. Navy, has been transferred from the Puget Sound Navy Yard at Bremerton, Wash., to duty in the Sixteenth Naval District, Cavite, Philippine Islands.

A. J. MCGAW, assistant professor of civil engineering at the University of Wyoming, has succeeded Russell B. Millay as city engineer of Laramie, Wyo. Mr. McGaw will serve until September 15, 1940.

JOHN R. PEAVY, until lately state maintenance engineer for the Alabama State Highway Department, has been appointed superintendent of the city water works at Mobile, Ala.

C. M. BARBER has resigned as engineer of highway planning for the Kansas State Highway Commission to accept a position with the Portland Cement Association. In the staff reorganization following Mr. Barber's resignation W. S. MCDANIEL, previously division engineer for the highway department, has been named assistant state highway engineer.

LLOYD H. FLICKINGER has resigned as engineering examiner in the regional office of the PWA at Chicago, to accept a position as structural designer with the Panama Canal at the Isthmus. He sailed from New York on June 13.

WALTER C. BURNHAM, engineer of Oklahoma City, Okla., has been appointed hydraulic engineer for the Grand River Dam Authority.

ARTHUR O. RIDGWAY recently received the Colorado Engineering Council's gold medal award for "distinguished engineering service." Mr. Ridgway, an organizer and first president of the Council, is chief engineer of the Denver and Rio Grande Western Railroad.

W. D. DEAN, contracting engineer of Richmond, Va., has been appointed manager of the Bureau of Contract Information, with headquarters in Washington, D.C.

GEORGE A. NELSON has resigned as chief of the Hydraulic Research Center at the U S. Waterways Experiment Station at Vicksburg, Miss., in order to accept the position of assistant hydraulic engineer for the Panama Canal, with headquarters at Diablo Heights, C.Z.

JOHN C. HABERER is now junior sanitary engineer in the Division of Sanitation of the New York State Department of Health and is located at Delmar, N.Y. Until recently he was assistant bio-chemist for the Consolidated Water Company of Utica, N.Y.

C. E. SPELLMAN, previously office engineer for the Central Nebraska Public Power and Irrigation District at Hastings, Nebr., has accepted a position in the Bureau of Yards and Docks, in Washington, D.C.

ARTHUR E. MORGAN, formerly chairman and chief engineer of the Tennessee Valley Authority, has returned to the presidency of the Dayton-Morgan Engineering Company, a position from which he resigned in 1933 to go to the TVA. CARL A. BOCK, consulting engineer of Dayton, Ohio, has returned to the company as vice-president, and C. C. CHAMBERS, until lately chief engineer of the Muskingum Conservancy District, has been made vice-president and general manager. The offices of the company have been moved from Dayton to Yellow Springs, Ohio.

W. H. WISELY has resigned as assistant sanitary engineer in the Division of Sanitary Engineering of the Illinois State Department of Public Health to become manager of the Urbana-Champaign (Ill.) Sanitary District.

FRITZ C. NYLAND, lieutenant-commander, Civil Engineer Corps, U.S. Navy, has been ordered detached from duty in the Navy Yard at Cavite, Philippine Islands, to do duty in the Navy Yard at Philadelphia, Pa.

LENOX R. LOHR has resigned as president of the National Broadcasting Company, with headquarters in New York City, in order to accept the position of president of the Chicago Museum of Science and Industry. Before assuming the presidency of the National Broadcasting Company—in 1936—Mr. Lohr was general manager of the Chicago Century of Progress.

H. G. SOURS, chief engineer of the Ohio State Highway Department, was inducted into office as president of the American Road Builders' Association at the annual meeting of the organization, which took place in Washington, D.C., in May. Mr. Sours will serve for a two-year term.

J. T. L. MCNEW, professor of highway engineering at the Agricultural and Mechanical College of Texas, has been appointed head of the engineering department there.

ALBERT H. POLLARD was recently promoted from the position of assistant engineer in the Materials and Tests Division of the Texas State Highway Department to that of field testing engineer in the Division. W. C. YOUNGS, JR., has been advanced from the position of research engineer to that of assistant engineer.

HAROLD K. BARROWS, professor of hydraulic engineering at Massachusetts Institute of Technology, will retire from the civil engineering department with the rank of professor emeritus. Professor Barrows, who also maintains a consulting practice in Boston, has been on the staff of the Institute for thirty-one years.

DECEASED

JACOB LOUIS BAUER (M. '09) consulting engineer of Newark, N.J., died at his home at Westfield, N.J., on May 14, 1940. Mr. Bauer, who was 71, became engineer of Union County (New Jersey) in 1898 and continued in this position for more than thirty years. From 1929 to 1933 he was New Jersey State Highway Engineer, resigning in the latter year to devote himself to his private engineering practice.

LEWIS VAN CARPENTER (M. '34) professor of sanitary engineering at New York University and director of the Sanitary Engineering Research Laboratory conducted jointly by the college and the city, died in New York on May 10, 1940, at the age of 45. Appointed to the faculty of the University of West Virginia, his alma mater, in 1923, he advanced rapidly, becoming professor of sanitary engineering by 1929. In 1935 he transferred to New York University. Professor Carpenter was the author of many articles on technical subjects and, until his fatal illness, was directing a large-scale investigation of land fills in cooperation with the New York Department of Sanitation. He was a veteran of the World War.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

ERNEST WILLARD CRAWLEY (Assoc. M. '10) senior engineer in the U.S. Engineer Office at Providence, R.I., died recently at the age of 60. In 1901 he graduated from Brown University. In 1902—after a brief connection with the New York, New Haven and Hartford Railroad—Mr. Crawley became a junior engineer in the U.S. Engineer Office, specializing in river and harbor engineering in Connecticut, Massachusetts, and Rhode Island. He was promoted several times, becoming senior engineer in 1939.

GEORGE GIBBS (M. '95) president of the consulting firm, Gibbs and Hill, Inc. New York City, died there on May 19, 1940, at the age of 79. Mr. Gibbs had been consulting engineer for the Baldwin Locomotive Company, for various Westinghouse electric subsidiaries, and for the Pennsylvania Railroad. An expert on rail electrification, he designed the electrical network for the Pennsylvania Station and was a member of the committee of experts that directed the electrifica-

tion of the New York Central Lines. He also designed the first all-steel railroad car. In 1917 he was a member of the Advisory Commission of Railway Experts sent to Russia by the U.S. Department of State.

GEORGE GIBBS

Long active in the affairs of the Society, Mr. Gibbs served as Director from 1906 to 1908. In 1911 he was the recipient of the Normal Medal, and in 1930 of the Arthur M. Wellington Prize.

ARTHUR LORENZO MILLS (M. '88) consulting engineer of New York City, died there recently. At one time Mr. Mills was vice-president of the Paddock Hodge Company, of Toledo, Ohio. Later, before coming to New York, he was for a number of years general manager of the Fort Smith and Western Railroad, at Fort Smith, Ark.

LOUIS MOLLER (Assoc. M. '07), superintendent of the Mount Emblem Cemetery at Elmhurst, Ill., died on April 29, 1940, at the age of 65. Mr. Moller was born and educated in Denmark, coming to the United States in 1902. Later he was, successively, in the employ of the New York Central and the Pennsylvania railroads and, at one time, was in charge of excavation work for Butler Brothers and Hoff, of New York City.

RALPH FENNO PROCTOR (M. '15) for the past three years manager of the Fidelity and Surety Department of the Association of Casualty and Surety Executives, New York City, died in Baltimore, Md., on May 30, 1940. He was 62. From 1903 to 1909 Colonel Proctor was a member of the firm of Williams, Proctor and Potts, and from 1909 to 1913 he was connected with A. L. Register and Company, of Philadelphia. From the latter year until 1937 he was with the Maryland Casualty Company, in Baltimore, serving successively as chief engineer, executive assistant, and vice-president.

JOHN WHEELER REID (M. '23) died at his home in Highland Park, Mich., on May 26, 1940, at the age of 67. Mr. Reid was in the employ of the City of Detroit from 1900 until his retirement in 1930, serving successively as draftsman, map and record clerk, engineer of grade separations, assistant engineer, engineer in charge of the Bureau of Grade Separation and Bridges, city engineer, and commissioner of the Department of Public Works. For two terms (1933–1934 and 1935–1936) Mr. Reid was state senator for the 18th Michigan District.

DAVID BARKER RUSHMORE (M. '07) died in New York City on May 4, 1940, at the age of 66. Mr. Rushmore was designing engineer for the Stanley Electric Manufacturing Company, of Pittsfield, Mass., from 1899 to 1905, and chief engineer of the Power and Mining Department of the General Electric Company from 1905 to 1925. In the latter year he retired and went to live at Washington, Conn. Mr. Rushmore was the author of numerous works on hydroelectric power plants and is credited with many improvements in the design of electrical machinery. He represented the United States at several international power conferences.

JOHN STEPHEN SEWELL (M. '05) president of the Alabama Marble Company, Highlands, N.C., died in Brevard, N.C., on April 20, 1940, at the age of 71. From 1899 to 1907 Colonel Sewell was constructing officer in charge of government building and from the latter year on, except for a period of war service, was with the Alabama Marble Company—first as vice-president and general manager at Gantts Quarry, Ala., and from 1919 on as president, with headquarters at Birmingham and, later, at Highlands. For his overseas service he received the U.S. Distinguished Service Medal and the French Legion of Honor. In 1906 he was the recipient of the Society's Norman Medal.

GEORGE SIMPSON (Assoc. M. '00) who retired in 1933 after twenty-five years as chief engineer for the Thompson-Starrett Company, New York City builders, died in New York on May 18, 1940. He was 71. A native of Scotland, Mr. Simpson was brought to this country as a child. During his connection with the Thompson-Starrett Company he was in charge of steel construction work on many notable metropolitan structures, including the Municipal Building. He was also engaged in reconstruction work in San Francisco after the earthquake.

GEORGE WILLIAM TILLSON (M. '96) died at La Grange, Ill., on May 13, 1940, at the age of 87. From 1881 to 1892 Mr. Tillson was in the employ of the city of

GEORGE W. TILLSON

Omaha, Nebr.—part of the time as city engineer. In 1895 he was appointed assistant engineer in direct charge of all pavement construction in Brooklyn, N.Y., holding this position until 1902 when he was appointed chief engineer of the Bureau of Highways of the Borough of Brooklyn. In 1907 he transferred to the same position in Manhattan, and in 1911 was made consulting engineer to the Borough President of Brooklyn. He resigned from the latter position in order to go to France and help direct the reconstruction of highways following the war. He was Director of the Society from 1907 to 1909, and in 1917 and 1918 he served as treasurer.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From May 10 to June 9, 1940, Inclusive

ADDITIONS TO MEMBERSHIP

ALLEN, ROBERT EWING (Jun. '40), Hydrologic Engr., SCS, U.S. Dept. of Agriculture, 4th Floor, Kuhns Bldg., Dayton, Ohio.

ALTIERI, AUGUST FRANCIS (Affiliate '40), Engr., PWA, North Interior Bldg. (Res., 601 Nineteenth St., N.W.), Washington, D.C.

AUTILIO, ALADINO ALFONSO, JR. (Jun. '40), Junior Engr., U.S. Engr. Dept., U.S. Engr. Office, Pittsburgh, Pa.

BELL, WILLIAM HENRY (Assoc. M. '40), Junior Topographic Engr., U.S. Geological Survey, Rolla, Mo. (Res., 1624 West 21st St., Little Rock, Ark.)

BERMAN, MORRIS (Assoc. M. '40), Asst. Engr., Dept. of Housing and Buildings, Bronx County Bldg., 161st St. & Walton Ave. (Res., 105 Macdougal St.), New York, N.Y.

BLOODWORTH, FRANK LAIR (Jun. '39), Junior Eng. Aid, U.S. Engr. Dept., Custom House (Res., 1620 Sixteenth Ave., South), Nashville, Tenn.

BRAUNSTEIN, ALFRED HILLEL (Jun. '40), Junior Engr., U.S. Engr. Office, War Dept., Federal Bldg. (Res., 5454 Stanton Ave.), Pittsburgh, Pa.

BRILL, ROYSE HARLAN (Jun. '40), Engr. (Constr.), Mount Haggin Land & Livestock Co., Box 640, Anaconda, Mont.

BRODBECK, ERNEST EDWARD (Jun. '40), Junior Engr., U.S. Engr. Office, 1001 Chamber of Commerce Bldg. (Res., 6703 Reynolds St.), Pittsburgh, Pa.

BROWN, JAMES GLENN (Jun. '40), Asst. Sanitarian, Eaton County Health Dept., 416 West Lawrence, Charlotte, Mich.

BROWNSON, VICTOR CARLETON (M. '40), Div. Engr., Board of Water Supply, City of New York, 346 Broadway, New York (Res., 71 Dwyer Ave., Liberty), N.Y.

COLBY, LESLIE ELDRIDGE (Jun. '40), Asst. Public Works Officer, C. E. C., U.S. Navy, Box 362, Parris Island, S.C.

COLLINS, REX IVAN (Assoc. M. '40), Consultant, 315 Arnote Bldg. (Res., 820 East Seneca St.), McAlester, Okla.

CRAWFORD, LAWRENCE C. (Assoc. M. '40), Dist. Engr., U.S. Geological Survey, 508 Hydraulics Laboratory, Iowa City, Iowa.

CROSBY, HEWITT, JR. (Jun. '40), Engr., Washington Gas Light Co., Twenty-ninth St., N.W. (Res., 1650 Harvard St.), Washington, D.C.

CROWTHER, JAMES IRVING (Assoc. M. '40), Staff Engr., Comm. on Governmental Efficiency and Economy, Inc., 900 Mercantile Trust Bldg., Baltimore, Md.

CUSHING, ROBERT MILNER (Assoc. M. '40), Asst. Engr., Headman, Ferguson & Carollo, 319 Homebuilders Bldg. (Res., 1631 Earll Drive), Phoenix, Ariz.

DECKER, WALTER ALPHONS (Jun. '40), Cadet Engr., Pennsylvania Power & Light Co., Box 587, Harrisburg (Res., 931 South 10th St., Allentown), Pa.

DYMOCK, JONATHAN LEON (Assoc. M. '40), Archt. and Engr., 136 Engle St., Englewood (Res., 46 Forest Rd., Tenafly), N.J.

FRANKFURTER, DAVID ROY (Jun. '40), 202 Republican St., Seattle, Wash.

HAMBLIN, CLIFFORD WILLIAM (Jun. '40), Junior Engr. (Civ.), U.S. Engr. Office, Huntington, W.Va.

HAMMES, KENNETH WILLIAM (Jun. '39), Field Engr., Miami Copper Co., Box 100 (Res., 926 Smith St.), Miami, Ariz.

HAUG, LESTER ANTHONY (Jun. '39), With Phillips Petroleum Co. (Res., 616 South Cherokee St.), Bartlesville, Okla.

HENDRICKS, ERNEST LEROY (Assoc. M. '40), Asst. Hydr. Engr., U.S. Geological Survey, Box 607, Ocala, Fla.

HIGGINS, THEODORE RUNDLETT (M. '40), Dist. Engr., Am. Inst. of Steel Constr., 101 Park Ave., New York, N.Y.

HIPPEY, FREDERICK ALLEN (Jun. '40), Chainman, Eng. Dept., N. & W. Ry., Main Office (Res., 1026 South Henry St.), Roanoke, Va.

HOBBS, SAMUEL (Assoc. M. '40), Field Engr., Portland Cement Assn., 816 West 5th St., Los Angeles (Res., 428 El Dorado St., Arcadia), Calif.

HODGES, PAUL VINCENT (M. '40), Hydrographic Engr., U.S. Indian Irrig. Service, 1236 Clarkson St., Denver, Colo.

HORNSBY, GROVER JACKSON (M. '40), Engr., Dept. of Interior, U.S. Bureau of Reclamation, Custom House, Denver, Colo.

KEMP, EULAS HINSON (Assoc. M. '40), Supt., Espy Paving and Const. Co., 108 East Bay, Savannah, Ga.

KENNEDY, JAMES PHILLIP (M. '40), Div. Engr., State Highway Dept. (Res., 1626 Viets Ave., Grand Forks, N.Dak.

KINZER, HUGH ROBINSON (Assoc. M. '40), Associate Civ. Engr., TVA, Knoxville, Tenn.

KRAMER, HARRISON WALLACE (Jun. '39), Sales Engr., H. D. Fowler Co., 1120 Eighth South (Res., 420 Belmont North), Seattle, Wash.

LANDY, JOSEPH ANTHONY (Jun. '39), Junior Engr., Board of Water Supply, City of New York, Shaft 16, Armonk (Res., 987 Summit Ave., New York), N.Y.

LANG, ROLLAND FRANCIS (Jun. '40), Instr., Civ. Eng. Dept., South Dakota State College (Res., 1107 Fourth St.), Brookings, S.Dak.

LANKFORD, LEONARD AVERA (Jun. '40), San. Engr., Dallas County Health Dept., Dallas, Tex.

LONGFELLOW, EDMUND HENRY (Jun. '39), Rodman, Testing Laboratory Technician, Met. Water Bureau of Hartford, East Branch Div., Barkhamsted (Res., Main St., New Hartford), Conn

MAIER, FRANZ JOSEPH (Jun. '40), Asst. Public Health Engr., U.S. Public Health Service, Sub-Treasury Bldg., Wall, Pine, and Nassau Sts., New York (Res., 7035 Broadway, Jackson Heights), N.Y.

MAIER, JOSEPH WILLIAM (Jun. '40), Junior Engr., U.S. Engr. Office, Federal Bldg. (Res., 366 South Graham St.), Pittsburgh, Pa.

MARSHALL, JAMES DAVIES (Assoc. M. '40), (Marshall & Brown), 114 West 10th St., Kansas City, Mo.

MATTHEWS, DENIS DEARMAN (Jun. '39), Care, Matthews & Mumby, Ltd., 129 Stockport Rd., Manchester 12, England.

MORCH, JOHN VALDEMAR (Jun. '40), Engr., E. C. Machin Co., Commonwealth Bldg., Allentown, Pa.

PAPAGEORGE, PAUL (Jun. '39), Maintenance Engr., John J. Mattia, 381 Court St. (Res., 984 East 2d St.), Brooklyn, N.Y.

PECK, ROBERT HILLES (Jun. '40), Klem Rd., Wester, N.Y.

PEREZ, LAWRENCE (Assoc. M. '40), Instr. Civ., Eng., Cooper Union, Cooper Sq., New York, N.Y.

PHILLIPS, ROBERT VAN NESS (Jun. '40), Senior Eng. Aid, State Div. of Highways, 10748 Weyburn Ave., Los Angeles, Calif.

PYZDROWSKI, STANLEY SIGISMUND (Jun. '40), 3410 Fleetwood St., Pittsburgh, Pa.

RAMSEY, PHILIP BRUCE (Jun. '40), Structural Engr., Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh, Pa.

REDMAN, RUSSELL PAUL (M. '40), Vice-Pres., Aetna Steel Constr. Co., 2340 Market St. (Res., 2664 Myra St.), Jacksonville, Fla.

RIMMER, JAMES STEPHEN (Jun. '40), Junior Civ. Engr., National Bureau of Standards, Connecticut Ave. and Upton St., Washington, D.C. (Res., 2 Jackson Ave., University Park, Md.)

ROSS, GEORGE LOUIS, JR. (Jun. '40), Asst. Eng. Aid, U.S. Engr. Dept., Box 59 (Res., 1711 Edgeland Ave.), Louisville, Ky.

SCHMID, ROBERT LYNDEN (M. '40), Chf. Engr., N. C. & St. L. Ry., 930 Broad (Res., 2702 Jones Ave.), Nashville, Tenn.

SCOTT, WARDNER GIBSON (Assoc. M. '40), (Scott & Scott), 618 First National Bank Bldg., Lincoln, Nebr.

SHAHANI, CHETANRAM MANGHARAM (Assoc. M. '40), With Braithwaite, Burn & Jessop Constr. Co., Ltd., Lall Bazaar, Calcutta, India.

SMITH, HESTER MOORE (Assoc. M. '40), Acting Regional Airport Engr., Civil Aeronautics Authority, Room 110, Meacham Field (Res., 4405 Pershing Ave.), Fort Worth, Tex.

SMYSER, MAURICE BOYER (Assoc. M. '40), Asst. Supt., Union Paving Co., Munsey Bldg., Washington, D.C. (Res., 402 Waring Rd., Elkins Park, Pa.)

STERN, ERNEST GEORGE (Jun. '40), Research Asst., Eng. Research, Pennsylvania State College, 706 South Allen St., State College, Pa.

STRIEGL, ALBERT ROLLIN (M. '40), Engr. (Civ.), U.S. Engr. Dept., 408 Federal Bldg., Milwaukee, Wis.

SUMMERS, ROBERT ORRELL (Jun. '40), Estimator, Clinton Constr. Co., 923 Folsom St., San Francisco (Res., 1230 Bonita Ave., Berkeley), Calif.

UTTON, JOHN CLAREMONT (M. '40), Field Representative, League of Minnesota Municipalities, 15 Univ. Library, Univ. of Minnesota (Res., 5024 South Lyndale Ave.), Minneapolis, Minn.

WADE, GEORGE EDWIN (Jun. '40), Univ. of Nevada Station, Reno, Nev.

WALKER, WILLIAM THOMAS (Jun. '40), 1515 West Clinch Ave., Knoxville, Tenn.

TOTAL MEMBERSHIP AS OF JUNE 9, 1940	
Members	5,647
Associate Members	6,469
Corporate Members	12,116
Honorary Members	31
Juniors	4,230
Affiliates	71
Fellows	1
Total	16,449

WARDEN, MAXWELL RINEHARDT (Assoc. M. '40), With E. I. du Pont de Nemours & Co. (Res., 115 West 37th St.), Wilmington, Del..

WASUNG, HENRY MARIAN (Jun. '39), Enumerator, U.S. Bureau of Census (Res., 539 Hunterdon St.), Newark, N.J.

WICKER, CLARENCE FELTON (Assoc. M. '40), Associate Engr., U.S. Engr. Dept., Philadelphia Dist. Office, Customs House, 2d and Chestnut Sts. (Res., 275 Harvey St.), Philadelphia, Pa.

WILLIAMSON, ARTHUR VAUGHN (M. '40), Senior Highway Engr., U.S. Public Roads Administration, 264 Custom House (Res., 600 Gaylord St.), Denver, Colo.

MEMBERSHIP TRANSFERS

ARMSTRONG, FRANCIS WALLIS, JR. (Jun. '31; Assoc. M. '40), Engr., Foundations, Inc., 61 East Main St. (Res., Barberry House), Moorestown, N.J.

ASHTON, EDWARD LOWELL (Assoc. M. '36; M. '40), Chf. Designer, Ash-Howard-Needles & Tammen, 1012 Baltimore Ave., Kansas City, Mo.

BARLOW, DEWITT DUKES (Assoc. M. '06; M. '40), Pres., Atlantic, Gulf & Pacific Co., 15 Park Row, New York, N.Y.

BERGLUND, GUSTAF ERIC (Assoc. M. '20; M. '40), Asst. Civ. Engr., The San. Dist. of Chicago, 910 South Michigan Ave. (Res., 704 Melrose St.), Chicago, Ill.

BREVIK, BERRY EDMUND (Assoc. M. '24; M. '40), Structural Engr., Portland Cement Assoc., 735 North Water St., Milwaukee (Res., 1602 Underwood Ave., Wauwatosa), Wis.

CAMPBELL, MAXWELTON SELWYN (Jun. '31; Assoc. M. '40), Asst. Public Health Engr., Div. of Public Health Eng., State Dept. of Health, 1412 Smith Tower, Seattle, Wash.

CARTER, HARRY VERN (Assoc. M. '28; M. '40), Sales Mgr., Structural Div., Tulsa Boiler & Machinery Co., Box 1978, Tulsa, Okla.

CAWLEY, CLIFFORD COMER (Jun. '34; Assoc. M. '40), Structural Engr., 1234 West 50th St., Los Angeles, Calif.

CREACY, THOMAS NELSON (Jun. '38; Assoc. M. '40), General Walker, Re-steel Dept., Consolidated Builders, Inc., Mason City, Wash.

DAVE, JOSEPH (Jun. '24; Assoc. M. '28; M. '40), Owner and Gen. Mgr., Dave Steel Co., Box 450, Asheville, N.C.

GROSSMAN, EGMOND EUGENE (Assoc. M. '30; M. '40), Management Engr., Gen. Realty & Utility Corp., 285 Madison Ave. (Res., 1111 Madison Ave.), New York, N.Y.

GUTHRIE, MARION CULBERTSON (Jun. '33; Assoc. M. '40), Design Engr., Refining Dept., Phillips Petroleum Co. (Res., 510 Delaware St.), Bartlesville, Okla.

HEALD, HENRY TOWNLEY (Assoc. M. '38; M. '40), Pres., Armour Inst. of Technology, 3300 Federal St., Chicago, Ill.

HECKLER, WILBUR LEROY (Jun. '29; Assoc. M. '40), Associate Engr., U.S. Geological Survey, Box 1311, Tucson, Ariz.

HENDRICK, WYATT BURL (Jun. '38; Assoc. M. '39), City Engr., City Hall, Lawton, Okla.

HESTER, JAMES TAYLOR (Jun. '31; Assoc. M. '40), Office Engr., Joint State Highway Dist. 10, 375 City Hall (Res., 1495 Eighteenth Ave.), San Francisco, Calif.

JAMES, RUSSELL WALKER (Assoc. M. '35; M. '40), Associate Highway Bridge Engr., U.S. Public Roads Administration, 254 Custom House (Res., 376 Clermont), Denver, Colo.

JOHNSTONE, WILLIAM JARL (Jun. '35; Assoc. M. '40), Bridge Designer, State Highway Dept., Box 188, Carson City, Nev.

JOST, HERMAN HENRY, JR. (Jun. '30; Assoc. M. '40), Hydr. Forecaster, Union Elec. Co. of Missouri, 315 North 12th St. (Res., 6301 Oleatha St.), St. Louis, Mo.

KITE, MAURICE BURTON (Jun. '38; Assoc. M. '40), Asst. Structural Engr., TVA, 701 Pound Bldg. (Res., 205 Island Ave.), Chattanooga, Tenn.

LYTLE, WILLIAM JOHN (Jun. '37; Assoc. M. '40), Constr. Supt., W. E. O'Neil Constr. Co., 2751 Clybourn Ave., Chicago (Res., 402 South Race St., Urbana), Ill.

MARANE, ALFRED CARL (Jun. '36; Assoc. M. '40), Asst. Structural Engr., Watts Bar Dam, TVA, Watts Bar Dam, Tenn.

MILLER, JOSEPH ALBERT (Assoc. M. '31; M. '40), Civ. Engr., Woodward Wight & Co., 451 Howard Ave. (Res., 2609 Nashville Ave.), New Orleans, La.

MILLS, DONALD (Assoc. M. '31; M. '40), Asst. Chf. Engr., J. B. McCrary Co., Inc., 22 Marietta St., Atlanta, Ga. (Res., 2103 Broadway, New Orleans, La.)

MILNER, WALKER WILSON (Jun. '34; Assoc. M. '40), Lt., Corps of Engrs., U.S.A., Quarters 179, West Point, N.Y.

NUZUM, CHARLES RICHARD (Jun. '36; Assoc. M. '40), Res. Engr., State Road Comm., Davis St., Keyser, W.Va.

POTTER, GRANT HAMBLETT (Assoc. M. '31; M. '40), Chf. Engr., Charles A. Maguire & Associates, 603 Turks Head Bldg. (Res., 199 Washington Ave.), Providence, R.I.

ROONEY, JAMES IGNATIUS (Assoc. M. '28; M. '40), Asst. Engr., Board of Water Supply, 346 Broadway, New York (Res., 3205 Eighty-First St., Jackson Heights), N.Y.

SANDERS, AZEL LABON RALPH (Assoc. M. '39; M. '40), Asst. Engr., Hazelet & Erdal, 53 West Jackson Blvd. (Res., 10729 Hale Ave.), Chicago, Ill.

SAWYER, LEON RANDOLPH (Jun. '30; Assoc. M. '40), Asst. Engr., U.S. Geological Survey, 230 Custom House, Denver, Colo.

SCOTT, SILAS STEELE (Jun. '30; Assoc. M. '40), Chf. of Party, Asst. Project Engr., State Highway Dept., Jackson (Res., Lucedale), Miss.

STEINMAN, JOHN JOSEPH (Jun. '29; Assoc. M. '39), Draftsman, State Div. of Highways, 2001 Van Ness Ave., San Francisco, Calif.

SWEAT, WESLEY ALBERT (Jun. '31; Assoc. M. '40), Location Engr., State Road Dept., Box 540, De Land, Fla.

VAYDA, EUGENE JOSEPH (Assoc. M. '29; M. '40), Asst. Engr. (Designer), Board of Water Supply, City of New York, 346 Broadway (Res., 3530 Decatur Ave.), New York, N.Y.

WHITE, HERBERT LEROY (Jun. '26; Assoc. M. '31; M. '40), San. Engr., Physical Plant Dept., Univ. of Illinois, 256 Administration Bldg. (Res., 507 West Delaware Ave.), Urbana, Ill.

WURZ, ARNOLD (Jun. '29; Assoc. M. '40), Camp Supt., SCS, Camp SCS-24, Box 575 (Res., 416 Leflore Ave.), Clarksdale, Miss.

REINSTATEMENTS

ALLEN, EDWARD RUSSELL, Assoc. M., reinstated May 31, 1940.

BRENNAN, WILLIAM ANDERSON, Assoc. M., reinstated May 13, 1940.

RESIGNATIONS

KARR, HORACE MITCHELL, Jun., resigned May 24, 1940.

MOULTON, ARTHUR GARLAND, Assoc. M., resigned May 24, 1940.

THOMAS, FRANCIS, Jun., resigned June 4, 1940.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

July 1, 1940 NUMBER 7

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

BOUCHARD, HARRY (Assoc. M.), Ann Arbor, Mich. (Age 51) (Claims RCA 9.0 RCM 13.8) Sept. 1929 to date Associate Prof. of Geodesy & Surveying, Univ. of Michigan.

BRUNKHORST, GEORGE WILLIAM, Rock Island Ill. (Age 47) (Claims RCA 12.9 RCM 6.5) Oct. 1938 to date Res. Engr., City of Rock Island; previously Res. Engr., City of Davenport, Iowa; Engr. for Consoer, Townsend & Quinlan, Chicago.

DALAL, CHOTALAL CHUNILAL, Hyderabad, Deccan, India. (Age 47) (Claims RCA 12.0 RCM 11.6) 1915 to date with Public Works Dept. and H. E. H., The Nizam's Govt., as Apprentice Engr., Asst. Engr., Asst. Chf. Engr., and Executive Engr.

DILLON, LEE SOMMERVILLE, Garden City, N.Y. (Age 47) (Claims RCA 0.8 RCM 22.8) May 1917 to date with Corps of Engrs., U.S. Army, in various capacities, since Nov. 1938 being Asst. to Dist. Engr., New York Dist.; at present Major.

EARNEST, GEORGE BROOKS (Assoc. M.), Cleveland Heights, Ohio. (Age 37) (Claims RCA 1.9 RCM 5.7) Sept. 1930 to Sept. 1935 Instructor in, and Sept. 1935 to date Asst. Prof. of, Civ. Eng., Case School of Applied Science, Cleveland, Ohio.

GILLETTE, GEORGE WILLIAM, Wilmington, N.C. (Age 51) (Claims RCA 2.2 RCM 21.9) March 1912 to date with Corps of Engrs., U.S. Army, at present as Lt. Col.; in command of Company, etc., and since Sept. 1938 Dist. Engr.

GLAZEBROOK, CHARLES STUART (Assoc. M.), Los Angeles, Calif. (Age 45) (Claims RCA 11.6 RCM 7.2) Feb. 1933 to date Structural Engr., Metropolitan Water Dist. of Southern California.

GRIFFITHS, DAVID WOOD, Little Rock, Ark. (Age 43) (Claims RCA 6.1 RCM 13.5) Dec. 1918 to date with Corps of Engrs., U.S. Army, as 2d Lieut., 1st Lieut. and Capt., since Nov. 1937 Asst. to Dist. Engr., Little Rock Engr. Dist.

KENNEY, NORMAN DURLING (Assoc. M.), Baltimore, Md. (Age 36) (Claims RCA 2.2 RCM 9.8) Feb. 1927 to date with Whitman, Requardt & Smith, as Draftsman, Designer, Valuation Asst., Computer, Chf. Draftsman, Layoutman, Prin. Asst., and at present Prin. Associate Engr.

KISSAM, PHILIP (Assoc. M.), Princeton, N.J. (Age 43) (Claims RCA 9.0 RCM 5.0) Jan. 1921 to June 1926 Instructor in, June 1926 to June 1935 Asst. Prof., and June 1935 to date Associate Prof. of, Civ. Eng., Princeton Univ.

LACROIX, ARTHUR EDWARD, Boston, Mass. (Age 45) (Claims RCA 8.6 RCM 11.4) Sept. 1916 to date (except March 1918 to June 1919) with New England Power Service Co., as Chf. of Party, Res. Engr., Asst. Engr., Engr., Report Mgr. and Executive, and (since Jan. 1936) Asst. Vice-Pres. of company and several subsidiaries, also Director of some subsidiaries

LAURENT, LOUIS EMILE, Cleveland, Ohio. (Age 66) (Claims RCA 6.0 RCM 26.0) 1917 to date Asst. Engr., Erie R.R. Co.

LOWRY, ROBERT LEE, JR. (Assoc. M.), Roswell, N.Mex. (Age 40) (Claims RCA 0.4 RCM 6.6) Nov. 1939 to date Hydr. Engr., National Resources Planning Board; previously Associate Engr. and Engr., Bureau of Reclamation, Water Resources Div., Denver, Colo.

MARSHALL, ALFRED COOKMAN, Detroit, Mich. (Age 67) (Claims RC 41.0) 1911 to date with The Detroit Edison Co. as Asst. to Pres., Vice-Pres. and Gen. Mgr., and at present Pres. and Gen. Mgr.

OLSON, WALTER SAMUEL, St. Paul, Minn. (Age 49) (Claims RCA 6.0 RCM 7.4) May 1920 to date with Minnesota Dept. of Conservation, Div. of Drainage and Waters as Office Engr., Deputy Commr., Deputy Director, and (since Sept. 1933) Director.

PATTERSON, WILLIAM DARYL (Assoc. M.), Sitka, Alaska. (Age 45) (Claims RCA 8.9 RCM 6.8) April 1917 to date with U.S. Coast and Geodetic Survey, 2 years as Aid, 3 years Jun. Hydrographic and Geodetic Engr., and 18 years Hydrographic and Geodetic Engr.; at present Lieut. Comdr.

RELF, JOSIAH FRANK, Stillwater, Okla. (Age 59) (Claims RCA 1.0 RCM 25.4) Aug. 1935 to date with SCS, Dept. of Agriculture as State Administrator of Nebraska, Associate Agri. Engr., and (since Aug. 1938) Engr., Project Okla. 1.

SCHAEFER, RUDOLPH FERDINAND (Assoc. M.), Mobile, Ala. (Age 52) (Claims RCA 5.7 RCM 17.2) 1939 to date Chf. Engr. of Design and Chf. Engr., Wilberding & Palmer, Inc.; previously Asst. Engr. and Asst. Engr. of Design, Port of New York Authority.

SCHOLER, EBEN ELLSWORTH (Assoc. M.), St. Louis, Mo. (Age 39) (Claims RCA 2.0 RCM 13.0) Sept. 1930 to date Highway Engr., Shell Oil Co., Inc.

SCHOLES, RICHARD THOMAS, Chicago, Ill. (Age 60) (Claims RCM 32.3) 1916 to date with Chicago, Burlington & Quincy R.R. Co., as Asst. Engr., and (since 1917) Asst. to Chf. Engr., etc.

SCHULTEN, WILLIAM JOHN, Jefferson City, Mo. (Age 45) (Claims RCA 3.0 RCM 13.1) Aug. 1923 to date with Missouri State Highway Dept., as Draftsman, Plans and Survey Engr., Asst. Div. Engr. in Charge of Surveys and Plans, and (since July 1937) Engr. on special assignment.

SEYFANG, WILLIAM GEORGE, Buffalo, N.Y. (Age 54) (Claims RCM 27.2) Dec. 1938 to date Managing Engr., Div. of Plant, Board of Education; previously with Buffalo Dept. of Public Works; Chf. Engr., Fleischmann Malting Co., Chicago, Ill.

WALDENMAIER, BERNHARDT ALBERT, Fayetteville, N.C. (Age 44) (Claims RCA 6.3 RCM 14.5) Aug. 1935 to date Field Engr. Representative (reporting to Director of Operations), FWA, WPA, Raleigh, N.C.

WARDEN, ROY ELISHA (Assoc. M.), Little Rock, Ark. (Age 59) (Claims RCA 8.1 RCM 23.8) June 1907 to date with Missouri Pacific R.R., St. Louis, Mo., as Maintenance-of-Way Inspector, Asst. Engr. and (since Aug. 1925) Engr. of Public Improvements.

WEBBER, WARD PERRY, Washington, D.C. (Age 56) (Claims RCA 11.3 RCM 12.0) Jan. 1925 to date with National Park Service as Draftsman, Asst. Engr., Park Engr., Associate Engr., Engr., Constr. Engr., and (since Feb. 1938) Chf. of Gen. Design Sec., Branch of Eng.

WOODHOUSE, GLENN ADELBERT, New York City. (Age 48) (Claims RCA 10.2 RCM 11.0) Oct. 1925 to date with American Water-Works Constr. Co., as Constr. Supt., Engr. and (since May 1931) Chf. Engr.

APPLYING FOR ASSOCIATE MEMBER

BARBER, PHILIP ERNEST, JR., Houston, Tex. (Age 33) (Claims RCA 7.2 RCM 2.0) Nov. 1932 to date with Humble Oil & Refining Co., as Chainman, Draftsman, Party Chf., Civ. Engr., Div. Chf. Draftsman, and Sept. 1939 to date Office Engr.

BELL, MACE HUDSON (Junior), New Orleans, La. (Age 32) (Claims RCA 2.0 RCM 4.7) Sept. 1932 to April 1934 Tech. Asst., and Nov. 1936 to date Dist. Engr., Am. Inst. of Steel Constr., Inc.; in the interim Senior Draftsman, and Asst. Res. Engr., U.S. Engr. Dept., Zanesville, Ohio.

BOESENECK, WALTER OSCAR, Lakewood, Ohio. (Age 46) (Claims RCA 15.2 RCM 0.8) May 1920 to date with Erie R.R. Co., as Draftsman, Leading Draftsman, Acting Asst. Chf. Draftsman, and (since Jan. 1931) Senior Draftsman.

BREWSTER, EDWARD DODD, Caracas, Venezuela. (Age 39) (Claims RCA 13.9) Feb. 1936 to date Gen. Mgr. in Mexico and Venezuela for The Armco International Corporation, Middletown, Ohio; previously Gen. Mgr. in Mexico for Western Metal Mfg. Co., Houston, Tex.

BROOKS, HAROLD PHILLIPS (Junior), Topeka, Kans. (Age 32) (Claims RCA 3.0) June 1930 to date with U.S. Geological Survey, Water Resources Branch, as Jun. Engr., and (since Oct. 1936) Asst. Engr.

BURGWIN, WILLIAM HAROLD, Kansas City, Mo. (Age 39) (Claims RCA 12.9 RCM 4.5) March 1923 to July 1926 and June 1927 to date with Missouri State Highway Comm., as Project Engr., Asst. Div. Constr. Engr., Div. Constr. Engr., Gen. Inspector, Asst. Engr. of Constr., and (since Aug. 1936) Div. Engr.

CALLAHAN, EZRA LEO, Inglewood, Calif. (Age 38) (Claims RCA 6.1 RCM 8.1) March 1936 to date Structural Engr., Atchison, Topeka and Santa Fe Railway Co.; previously Structural Engr., successively with C. E. Noerenberg, Archt. and Engr., and William D. Coffey, Cons. Engr., both of Los Angeles, Calif.

CAPWELL, CARL WAYLAND (Junior), Chula Vista, Calif. (Age 32) (Claims RCA 1.5) Nov. 1930 to date with San Diego Consolidated Gas & Elec. Co. in various capacities.

CLOSE, ROSS ARTHUR (Junior), Norfolk, Va. (Age 32) (Claims RCA 2.1) Aug. 1935 to Jan. 1936 Instrumentman, and April 1936 to date successively as Chf. of Party, Engr., and (since June 1939) Asst. to Engr., U.S. Engr. Office.

COCHRANE, JOSEPH DERR, St. Marys, Pa. (Age 34) (Claims RCA 2.4 RCM 3.4) June 1932 to March 1936 and Feb. 1940 to date with Borough of St. Marys, Pa., as Surveyor, Draftsman, Foreman, etc.; in the interim with Pennsylvania WPA, Dist. No. 10 as Project Engr.; Instrumentman and Draftsman, Renovo Div., Pennsylvania R.R. Co., Kane, Pa.

COZZA, MICHAEL RICHARD, Pittsburgh, Pa. (Age 35) (Claims RCA 6.2 RCM 2.0) May 1933 to June 1935 Draftsman, and July 1938 to date Senior Designing Engr. with City of Pittsburgh, Pa.; in the interim Project Engr. and Asst. Supt. of Maintenance, Pennsylvania Dept. of Highways, and Inspector of Constr., Allegheny County Authority.

DAVIS, PHILIP (Junior), Mobile, Ala. (Age 31) (Claims RCA 3.3 RCM 0.8) Sept. 1934 to date with U.S. Engr. Office on flood-control work in various capacities, since Aug. 1939 with Inspection Div. on aggregate study for future concrete work in Mobile Dist.

DUERR, ARLIE WILLIAM (Junior), Liverpool, N.Y. (Age 32) (Claims RCA 3.9 RCM 0.6) March 1937 to Feb. 1940 Res. Engr., and Operator with City of Massilon, Ohio; previously Supt. of Sewerage and Utilities Engr. for Orrville, Ohio.

FENNELL, EARLE JAMES, Rolla, Mo. (Age 34) (Claims RC 3.1) Feb. 1931 to Sept. 1932, Sept. 1933 to July 1935, Aug. 1935 to June 1936 and Oct. 1936 to date with U.S. Geological Survey as Eng. Field Aide, Jun. Topographic Engr., and (since Nov. 1937) Asst. Topographic Engr.

GAINES, FRANK PENDLETON (Junior), Nashville, Tenn. (Age 32) (Claims RCA 6.4) Nov. 1933 to date with U.S. Engrs., as Prin. Eng. Draftsman (Structural and Civil), Asst. Engr., and Associate Engr. (Civil).

GERARDY, MAURICE NORMAN, Detroit, Mich. (Age 44) (Claims RCA 12.8 RCM 8.3) Feb. 1922 to date Associate Civ. Engr. (Hydraulics), Detroit Dept. of Water Supply.

GRAGNOLA, JOHN ROBERT, New York City. (Age 33) (Claims RCA 11.7) March 1937 to Dec. 1938 Eng. Asst., Dept. of Sanitation and with Dept. of Public Works, New York City, and Dec. 1938 to date Eng. Inspector, Dept. of Public Works; previously Eng. Asst., with Board of Transportation.

GROSS, JOSEPH WILLIAM, Detroit, Mich. (Age 35) (Claims RCA 8.2 RCM 6.0) May 1929 to date with Board of Wayne County (Mich.) Road Commrs., as Engr., and (since Nov. 1938) Secy. and Office Engr.

HICKS, FRED LLOYD, Cleveland, Ga. (Age 39) (Claims RCA 5.0) April 1934 to date with Georgia State Highway Dept., Atlanta, Ga., in drafting office on highway design and details, etc.

HOPKINS, GEORGE FREDERICK, Seattle, Wash. (Age 39) (Claims RCA 6.9) March 1930 to June 1932 and Sept. 1933 to date with U.S. Engr. Office, as Jun. Engr., and (since Dec. 1937) Asst. Engr., being Chf. of Hydr. Sec.

KERSTING, EDWARD HENRY, Chicago, Ill. (Age 28) (Claims RCA 3.8) Aug. 1936 to date with Carnegie-Illinois Steel Corporation, training for mill and office detail work, and (since Aug. 1937) Steel Sheet Piling Engr.; previously Office Engr., Frazier-Davis Constr. Co., St. Louis, Mo.

LYMAN, CHARLES BENTON, Claverack, N.Y. (Age 43) (Claims RCA 13.5 RCM 1.0) April 1923 to date with Lane Constr. Corporation, Meriden, Conn., as Asst. Supt., Supt., Asst. Dist. Engr., and (since April 1940) Dist. Engr.

MASSEY, THEO, Birmingham, Ala. (Age 46) (Claims RCA 19.0) Sept. 1922 to date with Alabama State Highway Dept., as Res. Engr., and (since Jan. 1939) Asst. Div. Engr. in Chg. of Maintenance.

NICOL, ROBERT ATHELSTANE, Auckland, New Zealand. (Age 29) (Claims RCA 2.0) Nov. 1936 to date Designing Engr., Fletcher Constr. Co., Ltd.; previously Chainman, Rodman, and Draftsman, under L. W. Ward, Surveyor.

REIFF, JOHN ROBERT, Portland, Ore. (Age 33) (Claims RCA 2.3 RCM 4.0) Oct. 1933 to date with U.S. Engrs., as Draftsman, Jun. Engr., and (since Nov. 1935) Asst. Engr.

RUMMEL, EDWARD FRANK, Baltimore, Md. (Age 32) (Claims RCA 10.0) Aug. 1938 to date Designing Engr., Whitman, Requardt & Smith, Engrs.; previously Designing Draftsman, Bethlehem Steel Co., Sparrows Point, Md.; previously Jun. Engr. and Designing Engr., Sandlass & Wieman, Cons. Engrs., Baltimore, Md.

SANCHEZ DIAZ, JUAN HERMINIO (Junior), Mayaguez, Puerto Rico. (Age 32) (Claims RCA 3.6) Aug. 1932 to May 1935 Asst. Prof. of Mathematics, and Oct. 1935 to date Instructor in Civ. Eng., Coll. of Agri. & Mech. Arts, Univ. of Puerto Rico.

SCHMIDT, GEORGE EDWARD (Junior), Chattanooga, Tenn. (Age 32) (Claims RCA 5.8) Jan. 1936 to date Prin. Eng. Draftsman, TVA; previously Photogrammetrist, U.S. Forest Service, Columbia, S.C.

SCHWEGLER, RAMON MILES (Junior), Portland, Ore. (Age 32) (Claims RCA 5.6 RCM 2.0) June 1929 to Oct. 1937 Jun. Highway Engr., Oct. 1937 to July 1939 Asst. Highway Engr., and July 1939 to date Associate Highway Engr., with U.S. Bureau of Public Roads (PRA).

SIEKIELSKI, GEORGE STANLEY (Junior), Norris, Tenn. (Age 32) (Claims RCM 6.0) May 1934 to date with TVA as Asst. Engr.

SMITH, JOHN PALMER, JR., Diablo Heights, Canal Zone. (Age 37) (Claims RCA 9.6) Jan. 1940 to date Asst. Engr., Sec. of Office Engr., The Panama Canal; previously Asst. Engr., successively with Constr. Quartermaster, U.S. Army Headquarters, 3d Corps Area, Baltimore, Md., and Naval Air Station, Upham, Canal Zone.

SONESON, PHILLIP ERVIN, West Lafayette, Ind. (Age 37) (Claims RCA 7.8) Sept. 1930 to June 1938 Instructor, and June 1938 to date Asst. Prof., School of Civ. Eng., Purdue University.

STEVENS, ELMER BRADFORD, Balboa Heights, Canal Zone. (Age 39) (Claims RCA 7.0 RCM 3.0) May 1936 to Dec. 1938 Structural Designer, Jan.–July 1939 Asst. Engr., and Aug. 1939 to date Associate Engr., Sec. of Office Engr., The Panama Canal; previously Materials and Specifications Engr., Ohio WPA; Structural Engr., Dept. of Public Works, Cincinnati, Ohio.

STUART, CRUIKSHANK (Junior), Baltimore, Md. (Age 32) (Claims RCA 4.4) July 1938 to date Asst. Constr. Engr., Div. of Plans & Service, Bureau of Agricultural Chemistry & Eng., U.S. Dept. of Agriculture; previously Asst. Constr. Engr., The National Advisory Comm. for Aeronautics, Langley Field, Va.; Rodman and Levelman, Eng. Dept., Baltimore & Ohio R.R.

THOMPSON, KENNETH, Miami Beach, Fla. (Age 30) (Claims RCA 1.0 RCM 3.1) April 1936 to date with City of Miami Beach, Fla., as Draftsman, and (since Sept. 1938) Engr. of Design and Constr.

TUEMMLER, FREDERICK WILLIAM, Bayside, N.Y. (Age 38) (Claims RCA 6.0) Jan. 1939 to date with Dept. of City Planning, New York City, on comprehensive city planning for development of Master Plan of New York City; previously with topographical Bureau, Street Opening Div., Queens County.

WAGNER, EDWARD PLATT (Junior), New Hyde Park, N.Y. (Age 28) (Claims RCA 3.2 RCM 1.5) Aug. 1935 to date Associate Engr., E. L. Wagner, Civ. and San. Engrs., New York City.

WALTER, EARL FERDINAND, Manitowoc, Wis. (Age 37) (Claims RCA 11.7 RCM 5.2) July 1927 to date with City of Manitowoc, as Asst. City Engr., and (since May 1935) City Engr.

WEINSTEIN, HENRY (Junior), Louisville, Ky. (Age 32) (Claims RCA 3.1) Feb. 1934 to date with U.S. Engr. Office as Senior Draftsman, and (since Nov. 1938) Jun. Engr.

WHITE, FRANK PAUL, Pewaukee, Wis. (Age 32) (Claims RCA 6.1) Nov. 1938 to date Dist. Planning Engr., FWA, WPA, Milwaukee; previously Area Engr., WPA, and Senior Project Engr., ERA, both of Milwaukee, Wis.

WYLIE, MARSHALL JESSE (Junior), Albuquerque, N.Mex. (Age 32) (Claims RCA 6.5) June 1932 to date with New Mexico State Highway Dept., as Rodman, Instrumentman, Project Engr., and (since April 1939) Asst. Dist. Engr.

APPLYING FOR JUNIOR

AKIN, PHILMORE DONALD, Albuquerque, N.Mex. (Age 24) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

ALTENHOFEN, MATTHEW JOHN, Vicksburg, Miss. (Age 24) 1938 B.S., Eng. School, U.S. Mil. Acad.; June 1938 to date 2d Lieut., Corps of Engrs., U.S. Army, Vicksburg (Miss.) Dist.

ANDERSEN, MADS CLARENCE, El Campo, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

ANDERSON, ORMAN KEITH, Forest, Miss. (Age 21) 1940 B.S. in Civ. Eng., Miss. State Coll.

ASPLUND, GEORGE ALLEN, Enid, Okla. (Age 21) 1940 B.S., Okla. A. & M. Coll.

BAILEY, GEORGE WILLIAM, JR., Northampton, Mass. (Age 23) 1939 A.B., Dartmouth Coll. 1940 C.E., Thayer School of Civ. Eng.

BALFOUR, BURETTE HENRY, Tyler, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

BAUMLE, GILBERT EDWARD, Kendalville, Ind. (Age 25) 1940 B.S. in C.E., Purdue Univ.

BEAM, WALTER MYERS, New Castle, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

BEARD, ARTHUR HORNELL, JR., Indianapolis, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

BEJARANO, CARLOS ANTONIO, Lynbrook, N.Y. (Age 21) 1939 B.A., and 1940 B.S., Columbia Univ.

BELCHER, DONALD JENKS, West Lafayette, Ind. (Age 29) (Claims RC 2.3) July 1937 to date

with Purdue Univ., Lafayette, Ind., as Office Engr., Eng. Experiment Station, and (since Feb. 1939) Research Engr., Joint Highway Research Project; previously Eng. Clerk and Eng. Aide, U.S. Dept. of Agriculture, Bureau of Agri. Eng.

BIGGERSTAFF, SAMUEL PAUL, Evansville, Ind. (Age 23) 1940 B.S. in C.E., Purdue Univ.

BLAISDELL, EDWIN NORTH, Yonkers, N.Y. (Age 26) 1940 B.C.E., N.Y. Univ.

BLANKLEY, ROLAND GUNDER, Albuquerque, N. Mex. (Age 21) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

BLANKS, CHARLES PRESTON, JR., Meridian, Miss. (Age 27) (Claims RC 1.8 D 0.5) Sept. 1934 to July 1935 Instrumentman and Constr. Supt. for SCS; July 1935 to March 1936 Asst. Office Engr. in WPA; March 1936 to Sept. 1937 Area Supervisor of Malaria Control, Jackson, Miss.

BLYTHE, DAVID KNOX, Georgetown, Ky. (Age 23) 1940 B.S.C.E., Univ. of Ky.

BOYD, HAROLD WALTER, Thorntown, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

BOYER, HENRY FRANK, Pittsburgh, Pa. (Age 29) 1934 B. S. in Civ. Eng., Pa. State Coll.; Dec. 1936 to date Jun. Engr., U.S. Engr. Office.

BREHMER, HARRY ALBERT, Reynolds, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

BROWN, VERN MELVIN, Salt Lake City, Utah. (Age 22) 1940 B.S. in C.E., Univ. of Utah.

CARNS, JACK MILTON, Atlanta, Ga. (Age 25) (Claims RCA 1.5) Nov. 1938 to date Jun. Engr., U.S. Geological Survey; previously Jun. Eng. Aide, U.S. Waterways Experiment Station, and Mississippi River Comm.; Materials Inspector and Laboratory Asst., South Carolina Highway Dept.

CARPENTER, JOHN ERWIN, JR., Whitesboro, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

CLOUD, BRUCE BENJAMIN, San Antonio, Tex. (Age 20) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

COLLINS, CHARLES WILLIAM, JR., Sierra Madre, Calif. (Age 21) 1940 B.C.E., Univ. of Santa Clara.

CONKLIN, ROBERT HOLT, Riverside, Ill. (Age 22) 1940 B.S. in C.E., Purdue Univ.

CORNELL, ARTHUR ROSCOE, Port Washington, N.Y. (Age 21) 1940 B.S. in C.E., Purdue Univ.

COX, CHARLES WILLIAM, Brownstown, Ind. (Age 24) 1940 B.S. in C.E., Purdue Univ.

DASHE, WILLIAM, Hillside, N.J. (Age 22) 1940 B.S. in C.E., Purdue Univ.

DAVIS, BERRY FREDRICK, Dallas, Tex. (Age 20) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

DEES, ROBERT WILLIAM, Greenville, Ala. (Age 21) 1940 B.S. in C.E., Ala. Pol. Inst.

DORAN, JACK KENNEDY, Midland, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

DOSTER, THOMAS EDWIN, Lancaster, S.C. (Age 21) 1940 B.S. in C.E., Ga. School Tech.

EDWARDS, STACY WRIGHT, Miles, Tex. (Age 23) 1940 B.S. in Eng. Adm., Agri. & Mech. Coll. of Tex.

EISENGREIN, CHARLES HENRY, Prince Bay, S.I., N.Y. (Age 20) 1940 B.C.E., N.Y. Univ.

ELKINS, ROBERT EDWARD, Springfield, Mass. (Age 22) 1939 A.B., Dartmouth Coll. 1940 C.E., Thayer School of Civ. Eng.

ELSON, CHARLES ROBERT, Garrett, Ind. (Age 24) 1940 B.S. in C.E., Purdue Univ.

EVANS, GILES LINCOLN, JR., Cambridge, Mass. (Age 25) (Claims RC 0.2) Sept. 1939 to date graduate student, Massachusetts Inst. of Technology; previously Mil. Asst. to Dist. Engr., Memphis (Tenn.) Engr. Dist.

FARR, DONALD JOSEPH, Albuquerque, N.Mex. (Age 23) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

FERRELL, JAMES ORIN, Rolla, Mo. (Age 29) (Claims RC 1.2) 1940 B.S. in Civ. Eng., Mo. School of Min. & Met.; prior to 1938 (about 5½ years) Rodman, Foreman, Supt., etc., with various companies, including Missouri State Highway Dept., CWA, O.O. Fuller Constr. Co., etc.

FINK, ALBERT ADIN, Tucson, Ariz. (Age 22) 1940 B.S. in Civ. Eng., Univ. of Ariz.

FIRMAGE, DAVID ALLAN, Spanish Fork, Utah. (Age 22) 1940 B.S. in C.E., Univ. of Utah.

FISCHER, HENRY WALLACE, Hastings-on-Hudson, N.Y. (Age 22) 1940 B.C.E., N.Y. Univ.

FLORANCE, KIRK B., Red Cloud, Nebr. (Age 24) 1940 B.S. in C.E., Univ. of Nebr.

FOSTER, CHARLES ROBERT, Little Rock, Ark. (Age 27) Oct. 1936 to date with U.S. Engr. Office as Jun. Eng. Aide, Asst. Eng. Aide, and (since July 1938) Senior Eng. Aide; previously with SCS as Draftsman and Project Draftsman.

FOX, JOHN CLAYTON, Ft. Plain, N.Y. (Age 21) 1940 B.S. in C.E., Purdue Univ.

GARRETT, ARTHUR RICHARD, Tucson, Ariz. (Age 24) 1940 B.S. in Civ. Eng., Univ. of Ariz.

GARRY, ROBERT PETER, New York City. (Age 23) 1940 B.C.E., N.Y. Univ.

GRAHAM, STEPHEN EDMUND, JR., Santa Clara, Calif. (Age 24) 1940 B.C.E., Univ. of Santa Clara.

GREENBERG, LEROY FRANK, Newark, N.J. (Age 22) 1940 B.S. in C.E., Purdue Univ.

HAAS, EUGENE DUNBAR, JR., New York City. (Age 22) 1940 B.C.E., N.Y. Univ.

HAGGART, ROBERT STEVENSON, JR., Atlanta, Ga. (Age 21) 1940 B.S. in C.E., Ga. School Tech.

HALL, CHARLES EUGENE, Rolla, Mo. (Age 23) 1940 B.S. in Civ. Eng., Mo. School of Min. & Met.

HALL, WILLIAM HARVEY, Stillwater, Okla. (Age 29) 1940 B.S. in C.E., Okla. A. & M. Coll.

HAMILTON, WILLIAM ANDERSON, JR., Dallas, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

HAMMOND, DAVID GREENE, Vicksburg, Miss. (Age 26) July 1936 to date with U.S. Army, at present as 2d Lieut.

HANOVER, JOE GRADY, Wheelock, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

HARDMAN, RICHARD THORNLEY, Terre Haute, Ind. (Age 22) 1940 B.S. in C.E., Rose Pol. Inst.

HARRINGTON, HORRALL, Hazleton, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

HASLAM, LEGRAND, Murray, Utah. (Age 23) 1940 B.S. in C.E., Univ. of Utah.

HAYES, THOMAS ALOYSIUS, JR., South Orange, N.J. (Age 27) (Claims RCA 0.5) 1933 B.S. in Eng., and 1937 C.E., Princeton Univ.; April 1938 to date with New Jersey State Board of Commerce & Navigation, Newark, N.J., as Jun. Civ. Engr., Res. Engr. Inspector, and since March 1939 Jun. Hydrographic Engr.

HAZEN, ALLEN, Hanover, N.H. (Age 22) 1939 A.B., Dartmouth Coll. 1940 C.E., Thayer School of Civ. Eng.

HEILMAN, JOHN ELVIN, Lancaster, Pa. (Age 24) 1940 B.S. in C.E., Purdue Univ.

HERNES, RAYMOND JACOB, Albuquerque, N.Mex. (Age 24) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

HETTEMA, ROBERT MYRON, Angola, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

HILL, HERNDON SHULER, Albuquerque, N.Mex. (Age 21) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

HINSHAW, CONRAD SCHWARTZ, Houston, Tex. (Age 23) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

HODGES, EVERETT MACEY, Memphis, Tenn. (Age 23) 1940 B.S. in C.E., Purdue Univ.

HOFFMAN, RICHARD KLUDT, Los Angeles, Calif. (Age 23) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

HORTON, MORRIS CAVANAUGH, Wirt, Ind. (Age 29) 1940 B.S. in C.E., Purdue Univ.

HOTLER, CLARENCE FLOYD, Goodland, Ind. (Age 21) 1940 B.S. in C.E., Purdue Univ.

HOUSTON, KENNETH CLARK, Milwaukee, Wis. (Age 21) 1940 B.S. in C.E., Purdue Univ.

HUFFMAN, WILLIAM BRYNER, Salt Lake City, Utah. (Age 22) 1940 B.S. in C.E., Univ. of Utah.

HUTCHISON, JAMES RUSSELL, Albuquerque, N.Mex. (Age 23) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

JACKMAN, CLARENCE EVERETT, Chillicothe, Ohio. (Age 22) 1940 B.S. in C.E., Purdue Univ.

JACKSON, CARLTON KRUEGER, North Chicago, Ill. (Age 23) 1940 B.S. in C.E., Purdue Univ.

JEFFRIES, CHARLES COLE, Helena, Ark. (Age 22) 1940 B.S. in Civ. Eng., Miss. State Coll.

KEATING, LAMBERT DANIEL, Chicago, Ill. (Age 22) 1940 B.S. in C.E., Purdue Univ.

KRASHEN, HARRY, Kingman, Ind. (Age 29) 1940 B.S. in C.E., Purdue Univ.

KU, HSIEN-HSIANG, Hongkong, Hongkong (Age 22) 1940 B.S. in C.E., Purdue Univ.

LAFORCE, HARRY BERNHARD, Valparaiso, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

LAMASTERS, DAVID JOHN, Albuquerque, N.Mex. (Age 26) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

LANGTON, BERNARD BISHOP, Millis, Mass. (Age 25) 1939 S.B., Mass. Inst. Tech.; Aug. 1939 to date Jun. Eng. Aide, Massachusetts Metropolitan Dist. Water Supply Comm.

LINDERMAN, IRVING EDWARD, South Bend, Ind. (Age 25) 1940 B.S. in C.E., Purdue Univ.

LINDSTROM, ORVILLE RICHARD, Phoenix, Ariz. (Age 21) 1940 B.S. in Civ. Eng., Univ. of Ariz.

LOBDELL, ALFRED JAMES, Tucson, Ariz. (Age 22) 1940 B.S. in Civ. Eng., Univ. of Ariz.

LONGHI, RICHARD LESTER, Mt. Vernon, N.Y. (Age 24) 1940 B.C.E., N.Y. Univ.

LORANCE, ROBERT NEAL, Rolla, Mo. (Age 21) 1940 B.S. in Civ. Eng., Mo. School of Min. & Met.; July 1938 to date with U.S. Geological Survey as Asst. Draftsman and (at present) Draftsman.

LUCAS, LEONARD EDMOND, North Judson, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

LUCAS, WILLIS REID, Terre Haute, Ind. (Age 22) 1940 B.S. in C.E., Rose Pol. Inst.

LUTH, LOUIS ARTHUR, St. Louis, Mo. (Age 21) 1940 B.S. in C.E., Purdue Univ.

MCCARTY, ROBERT WHITE, Watertown, N.Y. (Age 24) 1939 A.B., Dartmouth Coll. 1940 C.E., Thayer School of Civ. Eng.

MCLAREN, HUGH, JR., Hollis, N.Y. (Age 23) 1939 A.B., Dartmouth Coll. 1940 C.E., Thayer School of Civ. Eng.

MCPHERSON, JOHN BARKLEY, Tucson, Ariz. (Age 22) 1940 B.S. in Civ. Eng., Univ. of Ariz.

MCWHORTER, GEORGE ELLSWORTH, JR., Milledgeville, Ga. (Age 21) 1940 B.S. in C. E., Ala. Pol. Inst.

MARSHALL, CHARLES THOMAS, Phoenix Ariz. (Age 25) 1940 B.S. in Civ. Eng., Univ. of Ariz.

MATHEWS, ELMER PHILIP, Starkville, Miss. (Age 24) 1940 B.S. in Civ. Eng., Miss. State Coll.

MATHIS, SAMUEL JACKSON, Columbia, S.C. (Age 27) July 1933 to June 1934 and June 1935 to date with South Carolina State Highway Dept., as Maintenance Clerk, Draftsman, Instrumentman, Asst. Res. Engr., and (since Sept. 1938) Office Asst. to State Highway Maintenance Engr.; in the interim Draftsman and Observer, U.S. Coast & Geodetic Survey, Washington, D.C.

MEYER, NORCLIFFE SANDFORD, JR., San Antonio, Tex. (Age 23) 1940 B.S. in Civ. Eng., Agri. & Mech. Coll. of Tex.

MITCHELL, MAX LEIGHTON, Clinton, Ind. (Age 24) 1940 B.S. in C.E., Rose Pol. Inst.

MOLZAHN, EDWIN LUDWIG, Chicago, Ill. (Age 20) 1940 B.S. in C.E., Purdue Univ.

MONTGOMERY, CHANCELLOR DAVID, Terre Haute, Ind. (Age 22) 1940 B.S. in C.E., Rose Poly. Inst.

MORETON, HAROLD ELMO, Rexburg, Idaho (Age 24) 1940 B.S. in Civ. Eng., Univ. of Utah.

MORGAN, ALBERT RUFUS, JR., Columbia, S.C. (Age 23) 1937 A.B., Univ. of S.C., 1940 B.S. in C.E., Georgia School Tech.

MORTON, GEORGE ARTHUR, Cincinnati, Ohio. (Age 24) 1940 C.E., Univ. of Cin.

MOSELEY, JOE CLIFTON, Junction, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

MOWRY, BOARDMAN SHAW, Chicago, Ill. (Age 22) 1940 B.S. in C.E., Purdue Univ.

MURPHY, GAYNOR ST. JOHNS TURNER, Frisco City, Ala. (Age 23) 1940 B.S. in C.E., Ala. Pol. Inst.

MYRICK, SAMUEL ALEXANDER, Kosciusko, Miss. (Age 24) 1940 B.S. in Civ. Eng., Miss. State Coll.

NOWAKOWSKI, EDWARD, Knoxville, Tenn. (Age 26) Feb. 1937 to date with TVA as Apprentice Eng. Draftsman, Jun. Eng. Draftsman, Asst. Eng. Draftsman, Eng. Draftsman, and (since July 1939) Jun. Mech. Engr.

OSWALT, WILLIAM HENRY, III, Dallas, Tex. (Age 21) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

PACHECO DOUGLAS, JOSE, San Juan del Rio, Mexico. (Age 29) (Claims RCA 2.4) Sept. 1935 to date with National Comm. of Irrigation as Designer, Field Engr., etc., and (since Jan. 1938) Res. Engr.

PARKHILL, WILLIAM HENRY, Washington, D.C. (Age 24) 1939 A.B., Dartmouth Coll. 1940 C.E., Thayer School of Civ. Eng.

PAUKEN, THOMAS NICHOLAS, Ft. Wayne, Ind. (Age 24) 1940 B.S. in C.E., Purdue Univ.

PECK, GEORGE SHERMAN, Geneva, Ill. (Age 22) 1940 B.S. in C.E., Purdue Univ.

PERRIN, FRANK WARREN, Cameron, Tex. (Age 21) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

PETERSON, CHARLES MAURITZ, Yonkers, N.Y. (Age 22) 1940 B.C.E., N.Y. Univ.

QUEBE, WILLIAM FRED, Indianapolis, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

RAYMOND, GILBERT JOHN, Fort Sheridan, Ill. (Age 25) 1940 B.S. in Civ. Eng., Univ. of Ariz.

REDMOND, JOHN, JR., Auburn, Ala. (Age 21) 1940 B.S. in C.E., Ala. Pol. Inst.

REILEY, RALPH LEONARD, West Lafayette, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

RIPPLE, ROBERT MARION, Staunton, Ind. (Age 24) 1940 B.S. in C.E., Rose Poly. Inst.

RISTAU, KENNETH EUGENE, Knoxville, Tenn. (Age 27) (Claims RCA 3.4) Feb. 1935 to date with Hydr. Data Div. as Under Eng. Aide, Asst. Eng. Aide, Jun. Civ. Engr., and (since June 1937) Asst. Civ. Engr.

RITTENHOUSE, TOM LOVELACE, Williams, Ariz. (Age 22) 1940 B.S. in Civ. Eng., Univ. of Ariz.

RODRIGUEZ, FEDERICO DAVID ADAMS, San Antonio, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

ROGERS, ELDON ALKIRE, Norman, Okla. (Age 21) 1940 B.S. in C.E., Univ. of Okla.

RUSHING, JAMES FORREST, Rolla, Mo. (Age 22) 1940 B.S. in Civ. Eng., Mo. School of Min. & Met.

RUTTER, MARTIN LUTHER, Pittsburgh, Pa. (Age 27) Sept. 1936 to date Instructor in Civ. Eng., Univ. of Pittsburgh; previously Head of Dept. of Structural Eng., Linsly Inst. of Technology, Wheeling, W. Va.

RYAN, FRANCIS ROBERT, Los Angeles, Calif. (Age 22) 1940 B.C.E., Univ. of Santa Clara.

SAMUELSON, DONALD ANDERS, Springfield, Ohio. (Age 22) 1940 B.S. in C.E., Purdue Univ.

SANDLIN, FRED COLE, San Angelo, Tex. (Age 23) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

SCALES, W. KENNETH, Albuquerque, N.Mex. (Age 27) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

SCHAKE, ELMER EDWARD, Davenport, Iowa. (Age 24) 1940 B.S. in C.E., Iowa State Univ.

SCHALLER, WILLIAM CHARLES, JR., Queens Village, N.Y. (Age 22) 1940 B.C.E., N.Y. Univ.

SCHICK, ROBERT ALLEN, Huntington, W.Va. (Age 25) 1940 B.S. in Civ. Eng., State Univ. of Iowa.

SCHRADER, HENRY CARL, Chicago, Ill. (Age 22) 1940 B.S. in C.E., Univ. of Ill.

SCHUMM, LOUIS WORLEY, JR., Dixon, Ill. (Age 21) 1940 B.S. in C.E., Univ. of Ill.

SCHWENDIMAN, GLENN, Salt Lake City, Utah. (Age 26) 1940 B.S. in C.E., Univ. of Utah.

SHACKLETON, ALLEN ROY, Chicago, Ill. (Age 23) 1940 B.S. in C.E., Purdue Univ.

SHARP, THOMAS FREDRICK, JR., Dallas, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

SHILLINGER, WILLIAM DANE, Connersville, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

SKINNER, RALPH DOUGLAS, Corning, Ark. (Age 25) 1940 B.S. in Civ. Eng., Miss. State Coll.

SMITH, LLOYD WILSON, Ft. Wayne, Ind. (Age 23) 1940 B.S. in C.E., Purdue Univ.

SYMANCYK, CLIFFORD ERNEST, Westfield, Mass. (Age 25) 1940 C.E., Thayer School of Civ. Eng.

TERRY, ALFRED GORDON, Memphis, Tenn. (Age 25) 1940 B.S. in Civ. Eng., Miss. State Coll.

THOMPSON, CHARLES BENJAMIN, Albuquerque, N.Mex. (Age 22) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

TOPPING, ALANSON DALE, West Lafayette, Ind. (Age 23) 1940 B.S. in C.E., Purdue Univ.

TRUJILLO, JOE ADOLPH, Albuquerque, N.Mex. (Age 22) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

TURNAGE, WILLIAM CLEVELAND, JR., Newhebron, Miss. (Age 25) 1940 B.S. in Civ. Eng., Miss. State Coll.

TURNBELL, RICHARD HENRY, Frankfort, Ind. (Age 21) 1940 B.S. in C.E., Purdue Univ.

ULRICH, FRED WILLIAM, West Lafayette, Ind. (Age 21) 1940 B.S. in C.E., Purdue Univ.

WABASHAW, CECIL CHARLES, Albuquerque, N.Mex. (Age 26) 1940 B.S. in Civ. Eng., Univ. of N.Mex.

WARD, JAMES BENJAMIN, Lenoir City, Tenn. (Age 25) (Claims RCA 4.0) Dec. 1933 to date with TVA as Jun. Geologic Aide, Asst. Geologic Aide, Jun. Geologist, Asst. Geologist, and (since July 1939) Associate Geologist.

WELCH, JOHN FRANK, JR., St. Louis, Mo. (Age 22) 1940 B.S. in Civ. Eng., Mo. School of Min. & Met.

WEST, JOHN RYLAND, Dallas, Tex. (Age 22) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

WHITEHOUSE, VERNON EDWARD, Terre Haute, Ind. (Age 21) 1940 B.S. in C.E., Rose Pol. Inst.

WHITSON, JAMES WILLIAM, Milford, Tex. (Age 25) 1940 B.S. in C.E., Agri. & Mech. Coll. of Tex.

WOO, HARRY THEUNG-YUEN, San Francisco, Calif. (Age 24) 1940 B.C.E., Univ. of Santa Clara.

WOOD, JACK RICHARD, Farmersburg, Ind. (Age 22) 1940 B.S. in C.E., Purdue Univ.

WOODSMALL, FRANCIS JOSEPH, Marshall, Mo. (Age 30) 1940 B.S. in C.E., Purdue Univ.

WRAY, EDWARD MOORE, North Vernon, Ind. (Age 25) 1940 B.S. in C.E., Purdue Univ.

ZYNDA, STANLEY GEORGE, Cleveland, Ohio. (Age 22) 1940 B.S. in Civ. Eng., The Citadel.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 132 of the 1940 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CONTRACTOR'S ENGINEER AND SUPERINTENDENT OF CONSTRUCTION; M. Am. Soc. C.E.; 25 years office and field, estimates, engineering, field construction; railroad grade-crossing eliminations, roads, bridges, sewers, wood and concrete piles, pipe lines (land or water). Immediate engagement anywhere, but prefer New York or New Jersey. C-720.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; 3½ years college; 8½ years road and bridge construction, design, all types of surveying, mapping, and drafting, and all types of testing experience; 1 year drafting, tracing—mechanical and electrical; 3½ years federal government, designing, estimating, supervising construction, handling heavy equipment, budgetary control, surveying, mapping. Location immaterial; available immediately. C-729.

GENERAL CONSTRUCTION AND DESIGN ENGINEER; M. Am. Soc. C.E.; 48; registered in Pennsylvania; 24 years experience in steel and concrete design, supervision of construction, supervision of engineering personnel, estimating, planning; bridges, highways, sewers, steel mills. Prefers position with owner N.E.; open for immediate engagement anywhere. C-730.

STRUCTURAL DESIGNER; Assoc. M. Am. Soc. C.E.; 34; 12 years experience divided between design, administration, and construction, chiefly on hydroelectric projects; supervised small municipal engineering organization. Capable of handling design squad on reinforced concrete or hydraulic structures, or of acting as office engineer on construction. C-733.

BUILDING CONSTRUCTION; Assoc. M. Am. Soc. C.E.; 35; married; 4 years at Massachusetts Institute of Technology, civil engineering; 8½ years experience in construction of schools, institutional and public buildings, water supply systems, power plants, and steam distribution systems, field and office supervision. Location immaterial; available on two weeks notice. C-736.

DESIGN

CIVIL ENGINEER; M. Am. Soc. C.E.; 40; graduate civil engineer; 11 years supervision of design and laying out of hydroelectric projects, power houses, spillways, locks, earth embankments, switchyards, transmission lines, and tunnels; 2 years design of structural steel and reinforced concrete bridges; 3 years electrification of railways. Available now. C-719.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 41; single; registered in Pennsylvania; 12 years experience in reinforced concrete and structural steel design; capable of handling anything from a sewer to a skyscraper. Location not essential; available immediately; connection with contractor acceptable. C-731.

EXECUTIVE

CIVIL ENGINEER; M. Am. Soc. C.E.; 41; graduate; licensed; Rotarian; Mason; executive, public speaker, writer; adaptable, versatile, cooperative, aggressive; experienced municipal engineering and administration, highways, buildings, sewers, United States, Mexico, and China. Desires position, North, Central, or South America. Free and willing to travel; now employed; sound connection with future more important than large salary. C-722.

ENGINEER; M. Am. Soc. C.E.; 27 years experience; design and construction of sewers water works; treatment plants and difficult tunnels. Had full charge of all phases of contracting business for past 10 years. Available at once as executive of engineering, contracting, or manufacturing business, or in municipal service. C-734.

JUNIOR

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; C.E., Cornell University; 6 months in construction before college; 3½ months as assistant superintendent during construction of sewage treatment plant; 10 months as inspector on $2,000,000 sewage treatment plant constructions. Desires position with engineering or contracting firm; available upon proper notice to employer. C-721.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; married; B.S., Columbia University; C.E., Columbia University; Theta Tau; high scholastic record; 1½ years experience in field, large foundation jobs; 9 months experience as job engineer and job office manager. Desires job with opportunity for advancement to position of responsibility. Will go anywhere. C-724.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; B.S.C.E., Rutgers University, 1938; 10 months supervising survey party on road location; 6 months drafting on arsenal utility and county maps; 3 months as field engineer on oil tank base construction; 8 months supervising revision of borough tax maps. Available immediately. C-725.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; B.S. and M.S. degrees with major in sanitary engineering; 4 years engineering and re-

L. G. CARLTON

Superintendent, Municipal Water Works of Springfield, Massachusetts.

writes:

One of the supply mains of the City of Springfield is a cast iron line laid 45 years ago, consisting of 14,300 feet of 36" and 14,300 feet of 30" pipe. During the ten year period just closed there have been no breaks of any kind on this line. There have been, however, four leaking joints which cost a total of $183.90 to repair. This would show an average maintenance cost of $3.52 per mile per year, for the last ten years.

Leland G. Carlton

LOW MAINTENANCE

is an economy factor in cast iron pipe that is usual, rather than exceptional, in water works experience. An impartial survey among nearly 200 water works superintendents shows that the maintenance cost of cast iron pipe is far below that of any other pipe material which has been in use long enough for the recording of conclusive data.

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search with state planning agency; 1 year topographic mapping; 6 months sanitary engineering. Desires experience in municipal engineering or administration; available upon proper notice to employer. C-726.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; desires work with general contractor; 1 year varied experience in building construction; 6 months of mechanical drafting. Salary secondary; location immaterial. C-732.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; B.S.C.E. (magna cum laude), University of Washington, 1938; M. Eng., Yale University, 1940; majored in structures; 2 years as part-time assistant at Yale University; 2 months drafting; 2 months surveying. C-735.

MUNICIPAL

CIVIL ENGINEER; M. Am. Soc. C.E.; 58; good health; 35 years experience in hydraulic and sanitary engineering, including large and small municipal water supplies, water purification plants, and sewage treatment works; experience includes responsible charge of preliminary investigations, design and construction, also considerable specification work. Available on two weeks notice. C-716.

CIVIC ENGINEER; Jun. Am. Soc. C.E.; 29; single; B.S.C.E. (with honors), Kansas State College, 1934; prepared for and interested in municipal engineering and administration; four years varied engineering employment; M.C.E. (materials), sanitation, government, planning and administration, Cornell University, February 1940; reserve officer on duty with regular army. Available October 1940. C-717.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; licensed; 4 years municipal engineering; 3 years administrative engineering; 4 years sanitary engineering. Employed; desires work in research, experimental, technical publication, or public relations; small town in Southwest or West preferred. C-723.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; B.C.E., Ohio State University; Ohio professional engineer's license; 31; married; 8 years highway experience; 6 years preparation of plans and designing; 2 years surveys and project engineer; 4 years responsible charge. Interested in highway safety engineering. Employed but available on short notice; references. C-727.

CIVIL ENGINEER; M. Am. Soc. C.E.; 54; vigorous good health; 30 years broad experience in hydraulic and sanitary engineering, particularly water supply, including primary responsibility in preliminary investigation, design, and construction on large work and small; well grounded in critical economic studies relating to basic problems of design. Available immediately. C-728.

TEACHING

PROFESSOR OF CIVIL ENGINEERING; Assoc. M. Am. Soc. C.E.; 53; member S.P.E.E.; registered professional engineer; broad experience in engineering and teaching and in plant management. Specialist in concrete. Capable of adequately handling executive position in education or industry. C-718.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 122 of the Year Book for 1940. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

AMERICAN SOCIETY FOR TESTING MATERIALS, Proceedings of the Forty-Second Annual Meeting held at Atlantic City, N.J., June 26–30, 1939, vol. 39. American Society for Testing Materials, Philadelphia, 1940. 1344 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth; $6 to members, $9 to non-members.

As usual, this large volume contains the summary of the proceedings at the annual meeting, the reports of the various committees, and the technical papers, with the discussions.

APPLIED MECHANICS, 4 ed. By A. P. Poorman. McGraw-Hill Book Co., New York, 1940. 354 pp., diagrs., charts, tables, 9½ × 6 in., cloth, $2.75.

In the new edition of this standard textbook certain material has been rearranged for purposes of simplicity or better continuity, and some new material has been added on moment of inertia of mass. New data for all problems have been given, and many problems have been added, all the numerical answers being given as before. The subject matter covers both statics and dynamics.

BRICK ENGINEERING, Handbook of Design. By H. C. Plummer and L. J. Reardon. Structural Clay Products Institute, Washington (D.C.), 1939. 400 pp., illus., diagrs., charts, tables, 9 × 6 in., fabrikoid, $4.

This is the first complete book to come to our attention on the design and construction of brick masonry. The properties of brick, mortar, and brick masonry are discussed thoroughly. Many types of structures are treated in both plain and reinforced brick masonry, this latter subject having received special treatment. There are numerous charts and tables for the design of reinforced brick masonry structures. The appendix contains tables for estimating quantities of masonry materials, standard specifications, bibliography, glossary of terms, etc.

CAVALCADE OF THE RAILS. By F. P. Morse. E. P. Dutton & Co., New York, 1940. 370 pp., illus., 10 × 6½ in., cloth, $3.75.

Again the panorama of rail transportation in the United States is surveyed. In narrative style the humble beginnings, persistent construction, rapid development, and present-day position of the railroads are presented, with their eventful history, dramatic moments, important personalities, and involved financial manipulations. The arrangement is not chronological in general. Each chapter carries its own theme over a considerable period.

ECONOMICS OF TRANSPORTATION IN AMERICA. By K. T. Healy. Ronald Press Co., New York, 1940. 575 pp., maps, charts, tables, 9½ × 6 in., cloth, $4.

From a survey of the large amount of economic data available concerning transportation, the author presents a study of economic forces and motives, and the reasons for economic phenomena in this field. Following a historical introduction come an analysis of demands for transportation and a résumé of the construction and development of transportation facilities. The functioning of these facilities and their regulation by government action are considered in detail. A brief supplementary bibliography and a list of railroad histories are appended.

EROSIONAL TOPOGRAPHY AND EROSION, a Mathematical Treatment. By J. M. Little. A. Carlisle & Co., San Francisco (Calif.), 1940. 104 pp., diagrs., charts, tables, 9½ × 6 in., cloth, $2.50.

The variables of hydraulics and hydrology which contribute to the erosional effects of both sheet and channel runoff are coordinated in this brief mathematical treatise. Data tables are included for practical application, and various specific calculations are developed in appendixes.

FLIGHT WITHOUT POWER. By L. B. Barringer. Pitman Publishing Corp., New York and Chicago, 1940. 251 pp., illus., diagrs., charts, tables, 9½ × 6 in., cloth, $3.50.

Gliding and soaring are comprehensively covered by various authorities. Following a brief historical summary there is an exposition of the aerodynamics of motorless flight. The design, construction, and maintenance of gliders, launching and soaring technique, meteorology, and instruments are discussed. There are chapters on flight training and soaring sites. A brief bibliography and a glossary are included.

IRON AND STEEL TO-DAY. (The Pageant of Progress). By J. Dearden. Oxford University Press, New York and Toronto, 1939. 190 pp., illus., diagrs., charts, tables, 9 × 5½ in., cloth, $1.75.

A simple, interesting account of the various processes used in the production of iron and steel products, with explanations of the reactions and reasons involved. The blast furnace, iron foundry, Bessemer converter, open-hearth and electric furnace are described. Casting, working, testing, heat treatment, and various grades of steel are explained. The book is one of a series on technical subjects by recognized English authorities.

MAGIC MOTORWAYS. By N. Bel Geddes. Random House, Inc., New York, 1940. 297 pp., illus., maps, 11 × 8 in., cloth, $3.50.

One of America's foremost designers explains what is wrong with highways, highway systems, and traffic management. He then presents a detailed plan for a new system of national motorways, incorporating in it a number of radical departures from present practice. The book is profusely illustrated with diagrams and photographs, including many of the Futurama designed by the author for the World's Fair exhibit of the General Motors Company.

MODERN STEELS, Manufacture, Inspection, Treatment, and Uses. Edited by E. E. Thum. American Society for Metals, Cleveland (Ohio), 1939. 374 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.50.

This volume contains the substance of a series of thirteen lectures delivered before the Pittsburgh chapter of the American Society for Metals. The topics discussed include the raw materials, the production of pig iron, the steel-making process, steel pouring, hot rolling and forging, inspection and testing, metallography, heat treatment, and alloy stainless and tool steels. The lectures are designed as practical introductions to these subjects, and are accompanied by exercises and suggestions for further reading.

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE, 6 ed. 1940. Lincoln Electric Co., Cleveland (Ohio), 1940. 1117 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth; $1.50 in the United States; $2 elsewhere.

Like preceding editions, this is intended as a reference book containing the basic information on arc welding. The various forms of arc welding are fully described, the welding of various metals is explained, and much space is devoted to designing machinery and structures for arc-welded construction. This edition has been carefully brought up to date, and considerably expanded.

PUBLIC AIDS TO TRANSPORTATION, 4 Vols. Published by Federal Coordinator of Transportation (for sale by Government Printing Office), Washington, D.C., 1940. Charts, tables, 11½ × 9 in., paper, vol. 1, 171 pp.; vol. 2, 316 pp.; vol. 3, 330 pp.; vol. 4, 317 pp. Available only in sets—$2.40 per set for 4 vols.

These reports present the results of an investigation, begun by the Federal Coordinator of Transportation and completed after that office ceased to exist, on "the extent to which public aid has been and is being given to the various modes of transportation." Vol. 1 explains the steps taken in determining the public aids received by the various forms of transportation, summarizes the underlying reports, compares the aids as to amounts and kinds and discusses the benefits they have conferred and the problems they have created, and includes the report on public aids to scheduled air transportation. Vol. 2 deals with public aids to railroad transportation, Vol. 3 with aids to transportation by water, and Vol. 4 with aids to motor vehicle transportation.

PUBLIC WORKS ENGINEERS' YEARBOOK 1940. American Public Works Association, Chicago (1313 East 60th Street), 1940. 338 pp., illus., diagrs., tables, 8½ × 5½ in., cloth, $3.50.

A complete report of the Public Works Congress, sponsored each year by the American Public Works Association, forms a substantial part of this volume. The 1940 papers range from traffic control and safety island design to the sanitary fill method of refuse disposal. There are also discussions on special topics not covered at the meetings, and a roster of membership.

SILICOSIS. (Studies and Reports, Series F, Industrial Hygiene, No. 17.) Proceedings of the International Conference held in Geneva from Aug. 29 to Sept. 9, 1938. International Labour Office, Geneva, Switzerland; U.S. Branch, 734 Jackson Place, Washington, D.C. 223 pp., illus., diagrs., charts, tables, 9½ × 6 in., paper, $1.25.

The various aspects of the silicosis problem, as discussed at the sittings of the conference, are presented here at length. Topics dealt with include recent advances in knowledge of the pathology of silicosis, the effect of other than siliceous dusts, pulmonary disease caused by dust inhalation, early diagnosis, new methods of dust investigation, determination of disability, dust prevention, personal protection, and specific therapy.

UP FOR AIR. By Frank Meier. E. P. Dutton and Company, Inc., New York, 1940. 287 pp., illus., 8½ × 5½ in., cloth, $2.75.

The author of this interesting and readable book has been "diving for a living" for many years—for the U.S. Navy, the New York City Department of Docks and Ferries, and finally as head of his own company. Diving for buried treasure and for pearls has received a great deal of publicity, but few realize that many engineering projects entail even more daring and sensational feats of diving.

VIBRATION OF RAIL AND ROAD VEHICLES. By B. S. Cain. Pitman Publishing Corp., New York and Chicago, 1940. 258 pp., illus., diagrs., charts, tables, 9 × 5½ in., cloth, $5.

The general principles of vibration are first discussed, mainly in a simple manner but with the use of advanced methods where necessary. Later sections discuss research and test methods, and progress in the design and operation of present equipment for automobiles, street cars, and railroad vehicles. A list of references is appended.

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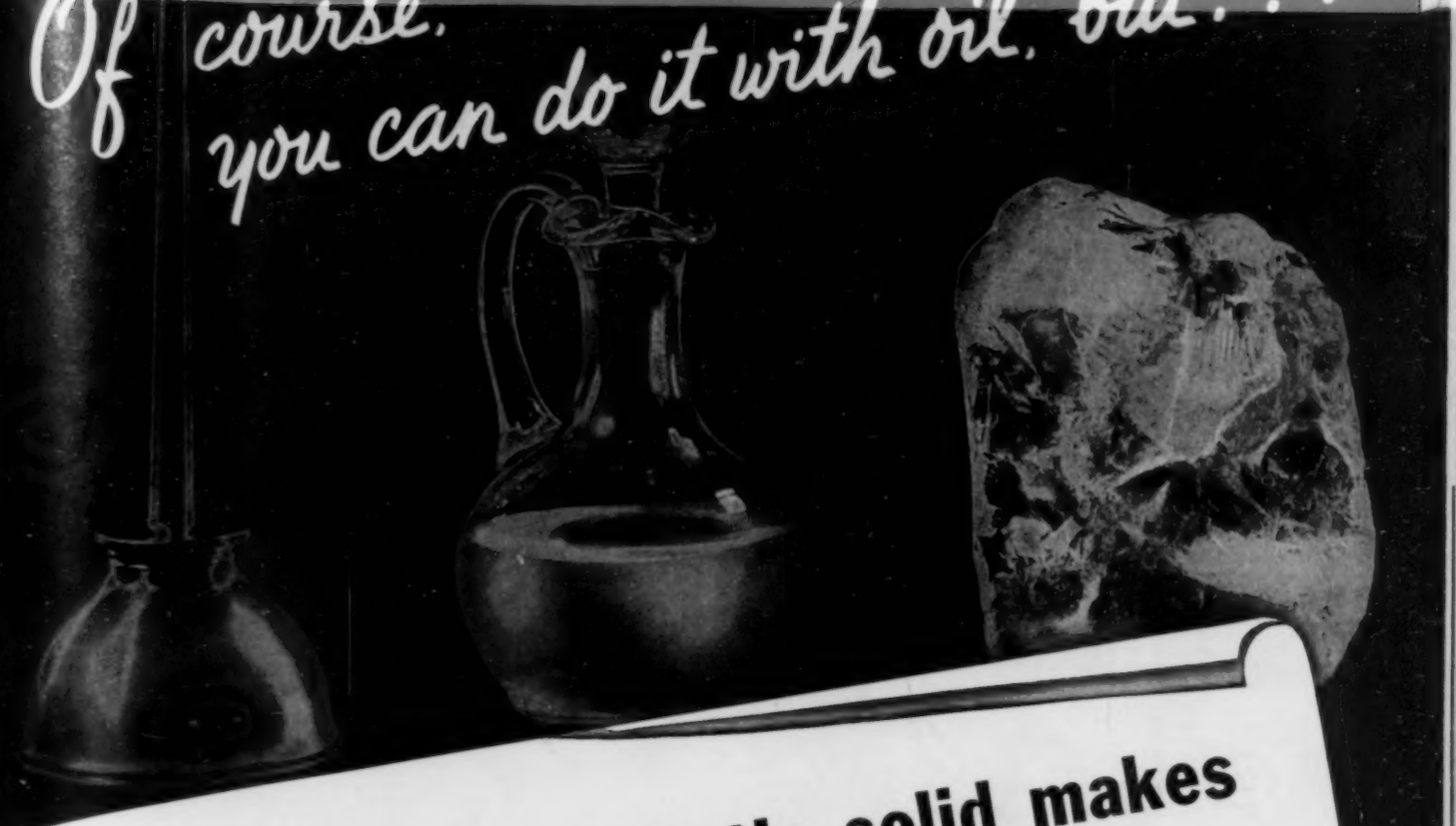

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BRIDGES

BRIDGES, STEEL ARCH, NIAGARA FALLS. Rainbow Bridge. *Roads & Bridges*, vol. 78, no. 2, Feb. 1940, pp. 9–11 and 58. Features of proposed single-span, ribbed-type, steel-arch bridge, having clear span of 960 ft and clearance of 217 ft between mean water level and crown of roadway, to be constructed at cost of $4,000,000 over Niagara River between Niagara Falls, N.Y., and Niagara Falls, Ontario.

CONCRETE ARCH, BELGIUM. La reconstruction du Pont d'Andenne sur la Meuse, R. Thiry and Elegeert. *Travaux*, vol. 23, no. 83, Nov. 1939, pp. 421–427 and 432; see also English abstract in *Civ. Eng.* (London), vol. 35, no. 404, Feb. 1940. Design and construction of new concrete arch bridge over Meuse River, at Andenne, Belgium, consisting of three spans 40.25 m to 41.50 m long; rise 5.3 m to 5.7 m; architectural treatment of bridge; results of tests.

CONCRETE ARCH, DEMOLITION. Bridge Demolition, E. C. Goldie. *Roads & Bridges*, vol. 78, no. 2, Feb. 1940, pp. 23 and 62. Methods used in demolition of reinforced concrete bowstring arch bridge, span length 76 ft, near Unionville, Ontario.

CONCRETE ARCH, ONTARIO. Henley Bridge. *Roads & Bridges*, vol. 78, no. 3, Mar. 1940, pp. 22–24 and 95–96. Design and construction of concrete arch twin bridge near St. Catharines, Ontario, having total length of 730 ft, maximum span 150 ft; substructure construction; pier design; pulling of centering piles; placing of concrete by pumping.

HIGHWAY, NETHERLANDS. Costruzione di Ponti Stradali in Olanda, A. K. W. Unger. *Strade*, vol. 21, no. 12, Dec. 1939, pp. 624–628. Features of most important highway bridges recently completed in Netherlands.

MAINTENANCE AND REPAIR. Maintenance Methods Used on San Francisco–Oakland Bay Bridge, R. A. Tudor. *Western Construction News*, vol. 16, no. 3, Mar. 1940, pp. 86–89. Organization of bridge maintenance operations, including inspection, cleaning equipment and painting procedure, lighting system, and care of roadway.

NETHERLANDS. Het berekenen van Boogbruggen met verstijvingsligger en de Rijksbruggenbouw, J. Emmen. *Ingenieur*, vol. 55, no. 5, Feb. 2, 1940, pp. Bt. 5–11, (discussion) Bt. 11–12. Design of arch bridges having stiffening trusses, as practiced by Government Bridge Construction Department of Netherlands; economics of this type of bridge design.

PIPE LINES, RIVER CROSSINGS. Natural Gas Pipe-Line Suspension Bridge Over Missouri River, G. R. Hunt. *Petroleum Engr.*, vol. 11, no. 6, Mar. 1940, pp. 120, 122, and 124. Northern Natural Gas Company's 16-in. line crosses Missouri River near Sioux City, Iowa; bridge 3,539.35 ft long, with total loaded length 2,640 ft, has main channel span of 1,320 ft with navigation clearance of 53.7 ft above U.S. Standard high water; details of design and construction, including sinking of caissons.

PLATE GIRDER, BELGIUM. Le nouveau pont de Longdoz sur la dérivation de la Meuse à Liége, A. Joachim. *Ossature Métallique*, vol. 8, no. 12, Dec. 1939, pp. 513–519; see also English abstract in *Civ. Eng.* (London), vol. 35, no. 403, Jan. 1940, pp. 22–24. Design and construction of partly welded steel plate girder highway bridge across derivation of Meuse River at Liége, Belgium, having single span 62 m long, total length 82 m.

RAILROAD, CANADA. Bridges for 68,000-Lb. Axle Loads, E. J. Napier. *Roads & Bridges* (formerly *Can. Engr.*), vol. 78, no. 1, Jan. 1940, pp. 17–19, 78, 80, and 82. Review of recent developments in design and construction of short-span railroad bridges in Canada for heavy modern axle loads; lifetime of steel; new designs; rigid frame bridges; architectural treatment; bridges of tomorrow.

VIADUCTS, PLATE GIRDER. Reconstruction of Kidwelly Viaduct. *Ry. Gaz.*, vol. 72, no. 8, Feb. 23, 1940, pp. 252–253. Viaduct reconstructed by Great Western Railway; structure carries up and down South Wales main lines over River Gwendraeth Fach; viaduct consists of four spans, each of 68 ft, giving total length of 272 ft; substructure is made up of two stone abutments and three piers sunk in river bed; each of piers comprises three concrete-filled wrought iron cylinders 6 ft in diameter, set 15 ft 1½ in. apart, and braced transversely at top with wrought iron girders to act as one unit.

VIADUCTS, PLATE GIRDER. Tabliers soudés pour voies de chemin de fer à la nouvelle gare du Midi à Bruxelles. *Ossature Métallique*, vol. 9, no. 1, Jan. 1, 1940, pp. 38–42. Design and construction of welded railroad viaduct for new Midi railroad station at Brussels, Belgium, consisting principally of 10 equal spans totaling 180 m in length.

BUILDINGS

ACOUSTICS. Some Practical Aspects of Architectural Acoustics, V. O. Knudsen. *Acoustical Soc. America—J.*, vol. 11, no. 4, Apr. 1940, pp. 383–389. Notion persists among many architects and builders that if acoustical material be specified and used in any room, even if limited to ceiling, acoustical requirements for that room have been satisfied; acoustical findings in certain of these rooms illustrate need for giving careful attention to several factors that determine outcome in room acoustics.

CONCRETE. Examples of Modern Buildings, L. Turner. *Structural Engr.*, vol. 18, no. 3, Mar. 1940, pp. 535–552. Structural features of various concrete buildings, including flour mill warehouse, hospital building of light weight construction, buildings and silos of distillery, and eight-story office building in London.

DESIGN. Some Unusual Structural Features in Recent Building Construction, L. S. White. *Structural Engr.*, vol. 18, no. 2, Feb. 1940, pp. 501–510. Description of noteworthy structural features of several recently completed buildings in Great Britain.

OFFICE. 79 Working Days, H. B. Winslow. *Steel*, vol. 106, no. 8, Feb. 19, 1940, pp. 46–48 and 83. Modern two-story and finished basement office building with 13,000 sq ft of floor space was erected at Ambridge, Pa., in 79 working days; fast erection was made possible largely through use of special cellular steel floor, roof and partition sections, bonded metal paneling for walls, and other advanced structural items; details of construction and methods employed.

STRUCTURES, STRENGTHENING. Strengthening of Structures, F. F. Binswanger. *Structural Engr.*, vol. 18, no. 3, Mar. 1940, pp. 553–557. Methods used in strengthening of several structures in South Africa, including ten-story building, concrete reservoir, etc.

WRECKING. Putting Construction Into Reverse Gear. *Construction Methods*, vol. 22, no. 4, Apr. 1940, pp. 54–56 and 110–111. Methods employed by Cleveland Wrecking Company for razing buildings and salvaging materials for resale; job organization; scheduling of work.

CITY AND REGIONAL PLANNING

HOUSING. Land, Materials, and Labor Costs, Washington (D.C.), U.S. Gov. Printing Office (Prepared for Indus. Committee of Nat. Resources Committee), *Housing Monograph Series, No. 3*, 1939, 101 pp., figrs., diagrs., tables. 30 cents. Symposium of papers on housing including following: Location Factors in Housing Programs, J. Crane; Site Planning, F. Bigger; Significance of Small House Design, P. Blouke; Building Materials and Cost of Housing, T. J. Kreps; Labor and Cost of Housing, M. G. Evans; Building Regulations and Housing Problem, G. N. Thompson.

CONCRETE

CEMENT. Hardening of Aluminous Cement at High and Low Temperatures, S. Gottlieb. *Cement & Lime Manufacture*, vol. 13, no. 4, Apr. 1940, pp. 55–60. Account of concrete works successfully carried out at temperatures as low as 0 F; results of tests on hardenings of aluminous cement at high temperatures; rate of hardening of aluminous cement mortar at various temperatures; heat evolution curve of neat cement; hardening at low temperatures; influence of various mixing times on hardening.

CONSTRUCTION, HANDBOOKS. Béton Armé (Agendas Dunod) 13 ed., V. Forestier. Paris, *Dunod*, 1940, 307 pp., diagrs., charts, tables, 26 francs. Handbook contains numerical and other data frequently wanted by engineers interested in reinforced concrete.

PERMEABILITY. Ein Beitrag zur Wasseraufnahme des Betons, F. Weise. *Zement*, vol. 28, no. 45, Nov. 9, 1939, pp. 653–656. Contribution to water absorption of concrete; method of testing water absorption and results of tests; comparison of values obtained with those required.

PIPE LINES, PROTECTIVE COATINGS. Protecting Pipe Lines with Concrete. *Gas*, vol. 16, no. 5, May 1940, pp. 58 and 60. To combat pipe-line deterioration from types of corrosive soil in Allegheny Mountain country, experiments were made with concrete sheaths; use of wood trough forms led to cracking of concrete because of uneven support after wood rotted; details of forms made of light weight galvanized sheets adopted by National Transit Company after several years of experimenting; concrete mixing and pouring procedure; costs reduced to less than 40 cents per running foot.

ROAD MATERIALS, AGGREGATES. Observations on Strength of Certain Highway Aggregates, F. G. Allison. *Am. Soc. Testing Mats.—Bul.*, no. 104, May 1940, pp. 19–24. Isolation of sand qualities; sand grading vs. tensile strength; effects of variables on mortar cube qualities; new method for fiber strength; pressure voids curves; principles establishing mortar and concrete strengths; rupture paths; surface texture and boundary effects; various kinds of attachment within concrete; etc. Bibliography.

DAMS

BUTTRESS, GREAT BRITAIN. Haweswater Dam, D. G. Davies. *Water & Water Eng.*, vol. 42, nos. 521 and 523, Mar. 1940, pp. 62–68, and Apr., pp. 151–153; see also *Civ. Eng.* (London), vol. 35, no. 403, Jan. 1940, pp. 12–16. Report of preliminary investigations, design and construction of monolithic buttress dam built of 44 independent buttresses widened at their ends to form continuous up-and-down stream faces, 144 ft maximum height, total length 1,540 ft, for water supply of Manchester, England; mining and placing of concrete; joints in concrete; cracks in concrete; temperature of concrete. Before Liverpool Eng. Soc.

CONCRETE GRAVITY, NORTH CAROLINA. Panel Forms Cut Setting and Stripping Costs at Hiwassee Dam, J. E. Walters. *Construction Methods*, vol. 22, no. 4, Apr. 1940, pp. 66–68. Economy of single course panel form developed and used at Hiwassee Dam, Tennessee Valley Authority project in North Carolina; form anchorage details; lifting of panel forms with aluminum A-frames and ratchet lever hoists; details of standard panel of wood forms designed for pouring 5-ft lifts of concrete.

CONCRETE GRAVITY. Tygart Dam. *Mar. News*, vol. 26, no. 10, Mar. 1940, pp. 48–50 and 57. Tygart River Reservoir Dam, concrete gravity structure, designed and built by U.S. Army Engineer; construction required over 3 years and cost $13,700,000; primary purpose of dam is to control flood waters originating in Tygart Valley and retain water in spring and early summer for release in late summer and fall; dam is located 2¼ miles above city of Grafton in Taylor County, W.Va.; at maximum spillway capacity it is capable of impounding over 377,000 acre-ft of water from drainage area of 1,183 miles.

EARTH, SOIL MECHANICS. Soil Mechanics at Shand Dam, A. W. F. McQueen and R. C. Mc-

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Mordie. *Eng. J.*, vol. 23, no. 4, Apr. 1940, pp. 161–172, (discussion) 173–177. Review of field exploration and soils testing carried out for earth embankments of Shand Dam, 74 ft maximum height, now under construction on Grand River in southern Ontario; results of typical shear test on impervious soil; flow net; field control and construction methods. Bibliography. Before Eng. Inst. Canada.

RESERVOIRS, FISH NUISANCE. Fish in Reser voir Resist Chemical Poisoning Effects. *Eng. News-Rec.*, vol. 124, no. 15, Apr. 11, 1940, p. 92. Concentrations of copper sulfate and rotenone heretofore considered to be lethal in their effect on fish life were ineffective when attempt was made to poison carp in reservoir at San Francisco.

FOUNDATIONS

CONCRETE. Reinforced Concrete Piles in Foundations, P. G. O'Rourke. *Civ. Eng. (London)*, vol. 35, no. 405, Mar. 1940, pp. 79–82. Abstract of paper discussing modern types of reinforced concrete piles; principal factors that should govern design of precast concrete piles. Before Inst. Civ. Engrs. of Ireland.

EARTH PRESSURE. Bemerkungen ueber neuere Erddruckuntersuchungen, A. Hertwig. *Veroeffentlichungen des Instituts der Deutschen Forschungsgesellschaft fuer Bodenmechanik*, no. 7, 1939, pp. 1–9. Critical discussion of Terzaghi theory of earth pressure, with special reference to its practical value.

UNDERPINNING. Modern Underpinning, R. V. Allin. *Civ. Eng. (London)*, vol. 35, no. 405, Mar. 1940, pp. 72–74. Review of modern underpinning methods, including "Chicago well" method and pretesting.

WATERPROOFING. Die Herstellung der Grundwasserabdichtung, Waldhauser. *Bitumen*, vol. 9, no. 10, Dec. 1939, pp. 154–157. Protection of building foundations and walls from ground water; use of asphalt impregnated fiber board for this purpose described; methods of application; fiber board used is obtained from waste textile fibers.

HYDRAULIC ENGINEERING

WATER HAMMER. Putting Damper on Surge, P. Hansen and P. E. Langdon. *Eng. News-Rec.*, vol. 124, no. 15, Apr. 11, 1940, pp. 93–94. In three long sections of water conduits in new Lake Erie supply system for Toledo, Ohio, each required different arrangements for damping surge; valve and interconnection methods, which were devised to meet special conditions encountered, described.

HYDROLOGY AND METEOROLOGY

GEOLOGY, SEDIMENTATION. Recent Shoreline Process, Brazoria County, Texas, W. H. Curry. *Am. Assn. Petroleum Geologists—Bul.*, vol. 24, no. 4, Apr. 1940, pp. 731–735. Geological note on conditions observed in connection with taking of series of aerial photographs, Dec. 9, 1938, followed by reflight of same area 42 days later; cloud in water off-shore had not appeared in first photographs; change in sedimentation status is attributed to storm of January 12 causing greater alluviation, drift along coast being effected by northeastward movement of cyclone.

RIVERS, CHINA. Hydrology of Yangtze River, H. Chatley. *Instn. Civ. Engrs.—J.*, no. 6, Apr. 1940, pp. 227–234, 2 supp. plates. Review of topography and hydrology of Yangtze River in China; water and silt discharge measurements. Bibliography.

INLAND WATERWAYS

CANALS, BELGIUM. Le Canal Albert. *Ossature Metallique*, vol. 8, no. 11, Nov. 1939, pp. 459–507. Symposium on steel structures on Albert Canal in Belgium, including following: Introduction, A. Delmer; Metallic Bridges of Albert Canal, G. De Cuyper; Characteristics of Principal Bridges of Albert Canal; Principal Hydraulic Structures of Albert Canal, H. N. F. Santilman; Characteristics of Albert Canal Locks; Coal Ports of Albert Canal.

IRRIGATION

CANALS, SILT CONTROL. Investigation of Interrelation of Silt Indices and Discharge Elements for Some Regime Channels in Punjab, N. K. Bose and J. K. Malhotra. *Punjab Irrigation Research Inst.—Research Publ.*, vol. 2, no. 23, 1939, 70 pp., supp. plates. Price 2s. 5d. Results of analytical investigation of observations on silt transportation in Punjab irrigation canal, taking special account of silt particle size and treating silt as physical and hydraulic entity. Bibliography.

LAND RECLAMATION AND DRAINAGE

LAND RESTORATION. Resoiling of Dredge Tailings. *Chem. Eng. & Min. Rev.*, vol. 32, no. 376, Jan. 10, 1940, pp. 223–225. Notes on dredging practice, working large area of alluvial flats along Macquarie River, in New South Wales; gravels carry gold values from about water level to bedrock, depths varying from 30 to 100 ft; overburden of sandy soil or loam averages about 36 ft thick; this is tripped in advance and conveyed astern to be discharged on top of wash tailings; soil bank is later leveled off by tractor-bulldozer; data on crops raised.

LANDSLIDES. Treatments Prevent Slides and Slip-outs in California, O. J. Porter. *Roads & Streets*, vol. 83, no. 4, Apr. 1940, pp. 57–59, 62–64, 66, 68, 70, and 72. Report on geological and soil studies for prevention of landslides on Northern California highways; foundation problems; causes of slides and slip-outs; layout of vertical sand drains topped by horizontal drainage pipe; pore pressure resulting from fill load on saturated compressible foundation soil; power drill for making foundation investigations; drainage trenches; subsoil drains.

RAILROAD MAINTENANCE OF WAY. Subdrainage Cures Sliding of High Fill. *Ry. Eng. & Maintenance*, vol. 36, no. 5, May 1940, pp. 320–322. Description of pipe lateral system installed on Illinois Central Railroad, which permitted abandonment of 466 ft of timber trestle.

MATERIAL TESTING

CONCRETE SLABS. Some Tests on Reinforced Concrete Slabs with Fixed Edges and Uniformly Loaded, L. G. Simms. *Structural Engr.*, vol. 18, no. 4, Apr. 1940, pp. 562–576. Tests by Building Research Station on reinforced concrete slabs fixed along all sides and subjected to uniform loading; tests on duplicate square slabs, each of 6-ft side and 4 in. thick, fixed on all sides; tests on rectangular slab 12 ft long, 6 ft wide and 4 in. thick fixed on all sides; ratio of theoretical failing loads and actual maximum loads of concrete slabs.

SOILS, PHYSICS. Ueber die Scherfestigkeit bindiger Bodenarten, H. Peynircioglu. *Veroeffentlichungen des Instituts der Deutschen Forschungsgesellschaft fuer Bodenmechanik*, no. 7, 1939, pp. 28–53. Results of experimental study of shearing strength of several types of cohesive soils using Casagrande shear testing apparatus; determination of angle of internal friction; Juergenson's squeeze test; factors affecting angle of internal friction. Bibliography.

SOILS. Portable Apparatus for Compression Tests on Clay Soils, L. F. Cooling and H. O. Golder. *Engineering*, vol. 149, no. 3862, Jan. 19, 1940, pp. 57–58. In course of work at Building Research Station of Department of Scientific and Industrial Research, convenient apparatus has been developed for carrying out tests on samples of clay soils; brief account of apparatus and way in which it can be used in fields; in addition, simple method of procuring test samples from depths down to 25 ft in soils is described.

MUNICIPAL ENGINEERING

GREAT BRITAIN. Municipal Engineering in 1939. *Surveyor*, vol. 97, no. 2505, Jan. 26, 1940, pp. 61–80. Review of 1939 progress in British municipal engineering arranged under following headings: roads and bridges, water supply, sewerage and sewage disposal, refuse collection and disposal, housing, town and country planning, municipal vehicles.

PORTS AND MARITIME STRUCTURES

CALIFORNIA. Ports of Golden State. *World Ports*, vol. 2, no. 6, Mar. 1940, pp. 6–9 and 24–25. Activities of 1939; improvements made and future trends with reference to California ports, including port of Los Angeles, port of San Diego, port of Oakland, and port of Stockton.

DOCKS. Construction of Deep-Water Quays. A. C. Gardner. *Instn. Civ. Engrs.—J.*, no. 6, Apr. 1940, pp. 129–152, supp. plate. Review of modern British and Continental European practice in design and construction of docks to accommodate modern ocean liners.

FIUME, ITALY. Die Grossen Haefen des Mittelmeeres. Der Hafen von Fiume, G. Tian. *Bauingenieur*, vol. 21, no. 9/10, Mar. 5, 1940, pp. 65–69. Review of development of port of Fiume, Italy, since end of eighteenth century to present day, with special reference to structures built within past 20 years.

NEWARK, N.J. Newark's Rapid Expansion. *World Ports*, vol. 2, no. 4, Jan. 1940, pp. 13 and 32. Data pertaining to Port of Newark, N.J.; historical review; imports and exports; freight handling facilities; future outlook.

PIERS, FIRE PREVENTION. Protecting Piers and Wharves from Fire, G. W. Booth. *World Ports*, vol. 2, no. 4, Jan. 1940, pp. 10–12 and 32. Some of structural features of older piers and wharves that are particularly objectionable from fire protection standpoint; menace of pier fires; reducing influence of structural defects; structural improvements for existing piers and wharves; fire protection and prevention; suggested Code for Piers and Wharves.

SHORE PROTECTION. Erfahrungen bei kuestenschutzbauten, Teuschi. *Zentralblatt der Bauverwaltung*, vol. 60, no. 7, Feb. 14, 1940, pp. 101–111. Discussion of effect of wave action on shore protection and port structures; examples from German experience with such structures.

SHORE PROTECTION. Proceedings of Annual Meeting, Washington, D.C., January 10, 1940. *Shore & Beach*, vol. 8, no. 2, Apr. 1940, pp. 31–62. Proceedings of 1940 annual meeting of American Shore and Beach Preservation Association including following papers and discussions: Annual Address by President, J. S. Smith; Status of Shore Protection Activities, T. M. Robins; Proposed New Jersey Waterfront Parks, A. A. La Fountain; Port Development as Related to Beaches, J. A. Crothers; Ten Years of Shore Protection, F. E. Schmitt; Beach Erosion Studies, J. J. Bain; Recreational Value of Water Areas, C. L. Wirth.

TEXAS. Lone Star State's Active Seaboard. *World Ports*, vol. 2, no. 5, Feb. 1940, pp. 11–15. Summary of activities during 1939 and observations on prospects for 1940, with reference to ports of Texas, including port of Houston, port of Galveston, port of Corpus Christi, port of Beaumont, and port of Brownsville.

ROADS AND STREETS

AIRPORTS, VANCOUVER. Vancouver's Sea Island Airport, W. Hill, Jr. *Roads & Bridges*, vol. 78, no. 4, Apr. 1940, pp. 19–21 and 89. Description of new Sea Island airport near Vancouver, B.C., for operation of land and seaplanes; layout of runways; construction of runway pavements.

BITUMINOUS. Tar Carpets, G. H. Fuidge. *Gas J.*, vol. 229, no. 4001, Jan. 24, 1940, pp. 187–189. Adhesion of bituminous binder depends largely upon character (particularly surface) of aggregate; design of carpet mixture consists in grading of aggregate including proportions of fines and of filler, and proportion of binder; commercial types of tar carpet; coarse and medium texture carpets; method for control of tar carpet manufacture. From paper presented through Instn. of Gas Engrs. to Public Works, Roads, and Transport Congress.

CULVERTS, DESIGN. Culverts for Mosquito Control. *Eng. News-Rec.*, vol. 124, no. 17, Apr. 25, 1940, pp. 72–73. Design of concrete box culverts of drainage system of Memphis, Tenn., so as to eliminate possibility of mosquito breeding; latest design providing shaped bottom to concentrate small flows; revamping of existing culverts; methods by which old culverts are reconstructed to meet present standards; grades and flow velocity.

DESIGN. Pavement Design, C. N. Conner. *Roads & Bridges*, vol. 78, no. 4, Apr. 1940, pp. 68, 70, 73–74, 76, and 78. Review of trends developed in both structural and geometric design of pavements; width of lanes; number of lanes; lane marking; median or dividing strips; superelevation; transition curves; flexible pavement design; rigid pavement standards; expansion and contraction; warping stresses. Before Purdue Univ. Road School.

DRAINAGE. Road Design on Level Areas, H. Criswell. *Surveyor*, vol. 97, no. 2509, Feb. 23, 1940, pp. 185–187. Comparative discussion of two design methods for securing adequate drainage of roads located across dead level countries.

EMBANKMENTS, CONSTRUCTION. Soil Science Applied to Construction of Embankments, C. E. Beland. *Roads & Bridges*, vol. 78, no. 4, Apr. 1940, pp. 28 and 79–81. Discussion of most important problems resulting from construction of high fills that can be solved by soil investigations; slide slope erosion; correcting landslides; maintaining optimum moisture; checking per cent compaction; rolling.

INTERSECTIONS. Ohio's First Cloverleaf, T. J. Kauer. *Roads and Streets*, vol. 83, no. 4, Apr. 1940, pp. 35–39. Design and construction of cloverleaf highway intersection near Cleveland, Ohio; estimated to cost $1,727,005; diversion of Cuyahoga River; roadway excavation; channel slope protection.

RAILROAD CROSSINGS, GATES. Gates at 16 Crossings on Grand Trunk Western. *Ry. Signaling*, vol. 33, no. 4, Apr. 1940, pp. 206–208. Grand Trunk Western Railroad protects all grade intersections with major highways in state of Illinois with short arm gates; one installation is manually controlled, two are auto-manual, and 13 are equipped for straight automatic operation.

RAILROAD CROSSINGS. These Three Grade Separations Will Cost $37,646,000. *Ry. Age*, vol. 108, no. 17, Apr. 27, 1940, pp. 737–740 and 743. Article discusses revival of work on three extensive rail-highway grade-separation projects on Long Island Railroad, subsidiary of Pennsylvania Railroad; Atlantic Avenue project in Brooklyn, which will cost $23,809,000; Rockaway Beach project, which will involve expenditure of about $11,650,000; and aqueduct grade elimination, which will entail expenditure of $2,187,000.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE. Activated Sludge Oxidations—VI, C. N. Sawyer. *Sewage Works J.*, vol. 12, no. 2, Mar. 1940, pp. 244–259. Results of simultaneous feeding experiments with activated sludge (concentration 1,000 ppm), at 10, 15, 20, and 25 C, and with activated sludge concentrations of 800, 1,600, 2,400, and 3,200 ppm. at 10 C and at 20 C, with 10-hour aeration period. Bibliography.

ACTIVATED SLUDGE. Buffer Values of Sewage During Purification, R. S. Ingols and H. Heukelekian. *Indus. & Eng. Chem.*, vol. 32, no. 3, Mar. 1940, pp. 401–404. Experimental study of

1½ gallons of fuel per hour.

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changes in alkalinity and pH values during aeration of sewage with activated sludge; comparison of buffer values of several sewages showing that they differ somewhat in quantity but not in quality; importance of ammonium bicarbonate in sewage buffer value; reduction of buffer values in aeration tank; reduction in buffer values between influent and effluent of trickling filter. Bibliography.

ACTIVATED SLUDGE. Carbon and Nitrogen Transformations in Purification of Sewage by Activated Sludge Process—III, H. Heukelekian and M. L. Littman. *Sewage Works J.*, vol. 12, no. 2, Mar. 1940, pp. 260–279. Results of experiments with three pure culture zoogleal sludges in suspended sludge solids, concentrations ranging from 526 to 1,777 ppm, aerated with sterile sewage for sufficient time to purify, and for longer periods to produce definitely over-aerated conditions; carbon and nitrogen analyses of settled liquor, Seitz filtrate, and sludge portions. Bibliography.

CHLORINATION. Problems and Progress in Chlorination of Sewage, A. E. Griffin and G. A. Campbell. *Sewage Works J.*, vol. 12, no. 2, Mar. 1940, pp. 307–313, (discussion) 313–320. Discussion of results of studies made at several plants relative to influent loads; methods of more adequately meeting chlorination problems which they create; new methods of sewage chlorination; potential chlorination with use of electrode system.

DISPOSAL PLANTS, GRIT CHAMBERS. Grit Chambers, M. B. Tark and J. J. Gilbert. *Water Works & Sewerage*, vol. 87, no. 4, Apr. 1940, pp. 186–189. Review of modern mechanized design and operating practices of grit chambers of sewage disposal plants; grit washing; operating data, Elizabeth, N.J.; features of spiral flow grit chamber employing compressed air. Before Am. Soc. Mech. Engrs.

DISPOSAL PLANTS, GRIT CHAMBERS. Grit—Its Collection and Washing, R. D. Nichols. *Water Works & Sewerage*, vol. 87, no. 4, Apr. 1940, pp. 190–193. Principles of modern design of mechanical units for screening out coarse solids, for removing deposited grit from settling chamber for washing of such deposits to free grit of organic solids, and return of dirty wash-water to sewage for subsequent treatment; detention periods; velocity of flow; relationship of length and depth of grit chambers; grit removal mechanisms. Before Am. Soc. Mech. Engrs.

DISPOSAL PLANTS, GRIT CHAMBERS. Grit Removal from Sewage, W. A. Kivell and N. B. Lund. *Water Works & Sewerage*, vol. 87, no. 4, Apr. 1940, pp. 176–185. Fundamental factors in grit separation; recommended basic standards of grit chamber design; sieve analysis of representative sewage grit from 21 plants; settling rates of quartz sand grains; theory of grit chamber design; application of new theory to common types of grit chambers; relation of particle size to settling area of five grit chambers in operation; flume tests to determine new design factor. Before Am. Soc. Mech. Engrs.

DISPOSAL PLANTS, INDIA. Sewage-Disposal of Delhi, J. A. R. Bromage. *Instn. Civ. Engrs.—J.*, no. 6, Apr. 1940, pp. 157–184 (discussion), 185–204, supp. plate. Design and construction of new sewage disposal system for Delhi, India, having peak capacity of 72 mgd, including pumping plants, settling and aeration tanks, etc.; electric power supply; chlorination of sewage; total cost £293,000.

FLOCCULATION. Improved Sewage Clarification by Pre-Flocculation Without Chemicals, A. J. Fischer and A. Hillman. *Sewage Works J.*, vol. 12, no. 2, Mar. 1940, pp. 280–302, (discussion) 303–306. Results of experimental study by development department of Dorr Company Inc.; laboratory and plant data showing that sewage clarification may be improved by use of pre-flocculation without chemicals; advantages of this principle in primary treatment of raw sewage.

OPERATION. Oldham's Reconstructed Sewage Purification Works: Notes on Operation, J. Taylor. *Surveyor*, vol. 97, nos. 2508 and 2509, Feb. 16, 1940, pp. 169–171, (discussion) Feb. 23, pp. 191–192. Review of one year's experience in operation of new sewage disposal plant of Oldham, England, serving population of 130,000; sludge digestion data; gas yield. Before Inst. Sewage Purification.

RESEARCH. Research in Sewage Chemistry, Sewage and Waste Treatment and Stream Pollution, W. Rudolfs and others. *Sewage Works J.*, vol. 12, no. 2, Mar. 1940, pp. 189–243. Critical review of American and European research literature of 1939 on sewage chemistry, sewage disposal, and stream pollution studies. Bibliography.

WEST INDIES. Sewerage of St. George's, Grenada. *Civ. Eng. (London)*, vol. 35, no. 405, Mar. 1940, pp. 69–71. Description of recently completed sewerage system of St. George's, Grenada, Windward Islands, costing about £50,000 sterling and serving population of about 5,000.

STRUCTURAL ENGINEERING

ALINEMENT CHARTS. Construction Design Charts for Field and Office Engineers, J. R. Griffith. San Francisco. *Western Construction News*, 1940, 109 pp. charts. $2. Collection of alinement charts, with examples illustrating their use, previously indexed from *Western Construction News* of 1935 to 1939, pertaining to concrete design, earthwork, area and yardage, highway design; hydraulics, structural design, etc.

BEAMS, CONTINUOUS. Convergence of Hardy Cross's Balancing Process, R. Oldenburger. *Am. Soc. Mech. Engrs.—Advance Paper*, Mtg., June 20–21, 1940, 5 pp. Cross method of structural analysis may be applied to given structure in such a manner that process does not converge; author gives necessary and sufficient conditions for convergence of Cross method, and exhibits convergent process of balancing any given structure; it is shown that balancing process can be described by real linear transformation; study restricted to case of continuous beam.

FRAMED STRUCTURES, BUCKLING. Crippling Load of Compression-Member in Framework with Stiff Joints, C. E. Inglis. *Instn. Civ. Engrs.—J.*, no. 6, Apr. 1940, pp. 205–226. Mathematical investigation of crippling load of strut forming part of framework with stiff joints, taking full account of change in flexibility of members due to axial thrust or pull; flexibility of member subjected to terminal bending moments combined with axial thrust or with axial pull; terminal rotation produced by given terminal couple; experimental verification of theory.

FRAMED STRUCTURES, STRESS ANALYSIS. Rigid Frame Analysis, J. Mason. *Structural Engr.*, vol. 18, no. 4, Apr. 1940, pp. 577–583. Outline of original stress analysis of rigid frames by successive approximations, which is alleged to be simpler and quicker than that of Professor Cross.

PLATES, BUCKLING. Problem of Buckling of Elastic Plates of Variable Thickness, R. G. Olsson and E. Reissner. *J. Mathematics & Physics*, vol. 19, no. 2, Apr. 1940, pp. 131–139. Theoretical mathematical discussion of elastic stability of rectangular plate uniformly stressed in its plane and freely supported along edges, while its stiffness varies linearly in direction parallel to one pair of edges.

TUNNELS

HOSPITALS. Design of Piping Service Tunnel at Chronic Disease Hospital Described, R. Grahn and T. S. Tenney. *Heating, Piping & Air Conditioning*, vol. 12, no. 3, Mar. 1940, pp. 168–169. Tunnel serves double purpose of carrying various piping from boiler house to ward buildings, and provides clean, lighted, and ventilated walkway for nurses and other personnel; details of tunnel piping described.

VEHICULAR, MOBILE, ALA. Mobile Builds Vehicle Tunnel for Gulf Coast Highway Traffic. *Eng. News-Rec.*, vol. 124, no. 17, Apr. 25, 1940, pp. 42–46. Design and construction of single-tube vehicular tunnel, 3,400 ft long, being built under Mobile River at Mobile, Ala.; ground conditions; tunnel lining; lighting; tube construction; features of simplified ventilation system.

WATER SUPPLY, NEW YORK. Rapid Tunnel Driving on Delaware Aqueduct. *Water Works Eng.*, vol. 93, no. 8, Apr. 10, 1940, pp. 427–432. Progress report on construction of 85-mile continuous rock tunnel for bringing Delaware water supply to New York City; features of equipment used; drills of New York pattern; review of methods.

WATER PIPE LINES

CORROSION. Corrosion Control at Lewiston, Idaho, W. P. Hughes. *Water Works & Sewerage*, vol. 87, no. 4, Apr. 1940, pp. 172–175. Experience of water works of Lewiston, Idaho, with use of lime and aluminum sulfate for anti-corrosive interior coating of water-pipe lines.

CROSS CONNECTIONS. Cross Connection Practices, J. S. Longwell. *Water Works Eng.*, vol. 93, no. 8, Apr. 10, 1940, pp. 433–434, 437, and 491. Program of East Bay Municipal Utility District of Oakland, Calif., for elimination of dangerous cross connections in water pipe lines; metal-to-metal checks; results of inspections.

CULVERTS, CONSTRUCTION. Jacking 72-Inch Culvert Pipe Under Outfall Sewer, R. Shepherd. *Am. Water Works Assn.—J.*, vol. 32, no. 3, Mar. 1940, pp. 414–422. Method of jacking 72-in. 10-gage culvert pipe, about 24 ft long, under outfall sewer in Baltimore, Md.; installation of 36-in. cast iron main in culvert pipe.

FROST EFFECT. Notes on Frost Damage to Plumbing Work, C. W. Craske. *Surveyor*, vol. 97, no. 2508, Feb. 16, 1940, pp. 163–164. Suggestions on design and installation of plumbing details to secure them against frost damage; frost protection of pipes, galvanized storage tanks, tank trays and overflows, stopcocks, etc.

SERVICE CONNECTIONS. Conditions Covering Installation of Lead Service Pipe, R. L. Ziegfeld. *New England Water Works Assn.—J.*, vol. 54, no. 1, Mar. 1940, pp. 1–15. Review of performance of lead service pipe under modern water supply conditions; characteristics and classification of lead service pipe; corrosion of lead pipe; installation of lead pipe.

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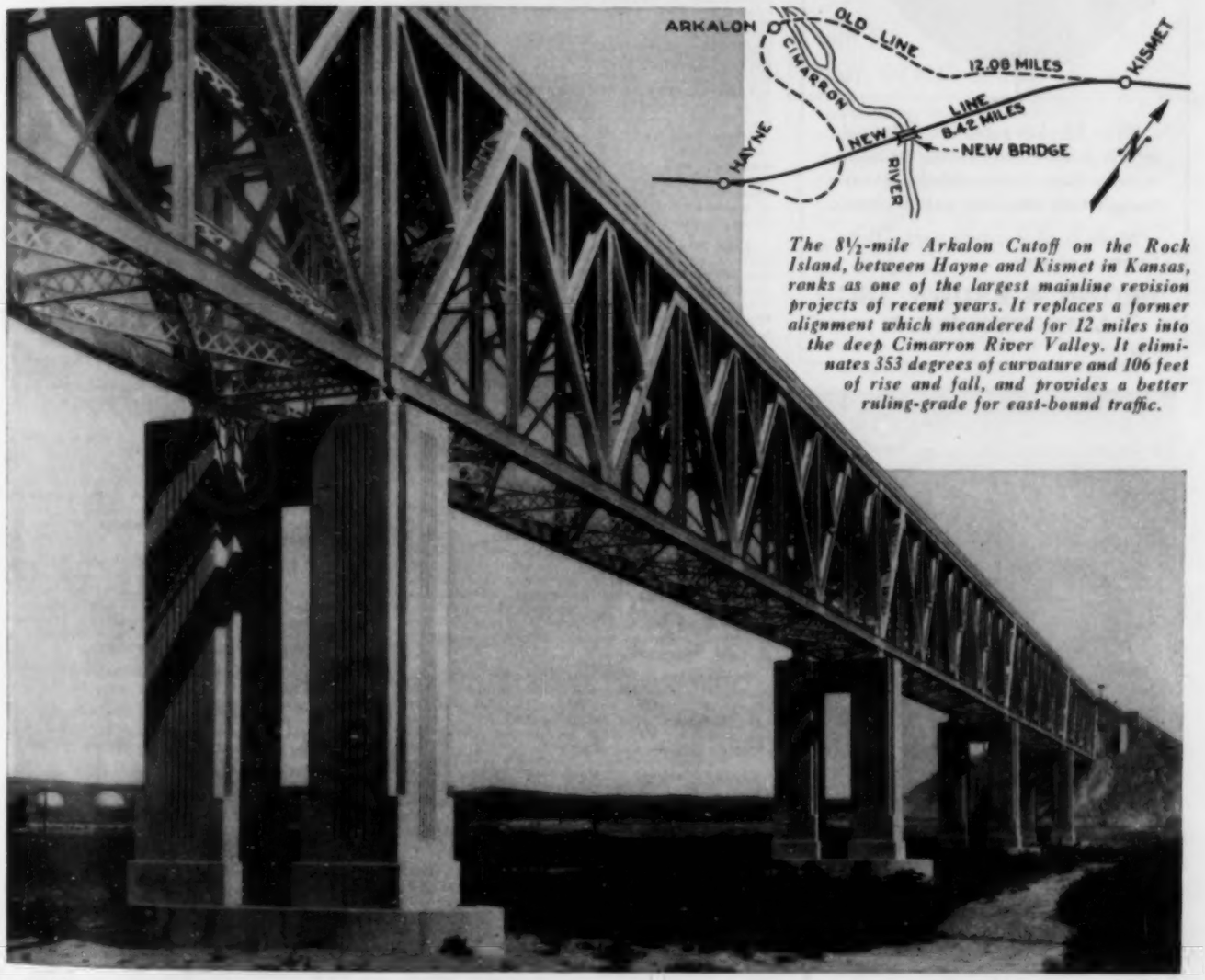

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WATER TREATMENT

ACTIVATED CARBON. Handling and Feeding Activated Carbon at Detroit, N. Powers. *Am. Water Works Assn.—J.*, vol. 32, no. 4, Apr. 1940, pp. 621–624. Report on difficulties encountered and methods now used successfully in handling and feeding of carbon at Water Works Park filtration plant in Detroit.

ACTIVATED CARBON. Use of Activated Carbon in Purification Plants, O. J. Ripple. *Am. Water Works Assn.—J.*, vol. 32, no. 4, Apr. 1940, pp. 609–612. Description of use of activated carbon at Moffat Filter Plant at Denver, Colo. Bibliography.

ACTIVATED CARBON. Use of Granular Activated Carbon at Bay City, L. B. Harrison. *Am. Water Works Assn.—J.*, vol. 32, no. 4, Apr. 1940, pp. 593–608. Plant and laboratory experiences with granular activated carbon, since 1930, in Bay City, Mich.; apparatus used in determining relative activities of granular carbon units; phenol removal by granular carbon layers; use of large particles as substratum; phenol removal by granular carbon layers and rejuvenation of such layers with potassium permanganate solution; reversibility of granular carbon layer.

ANALYSIS, PHENOL DETERMINATION. Determination of Phenol, L. S. Renzoni. *Water & Sewage*, vol. 78, no. 3, Mar. 1940, pp. 36–38. Description of sensitive test for determination of phenol present in minute quantities in water containing sodium sulfides. Before Am. Water Works Assn.

ANALYSIS. Use and Limitations of Conductivity Measurements of Well Water Quality, K. W. Brown. *Am. Water Works Assn.—J.*, vol. 32, no. 4, Apr. 1940, pp. 675–687, (discussion) 687–691. Review of procedure for measuring electric conductivity of water for rough determination of total mineral contents, which may also serve as check on accuracy of chemical analysis; well test procedure; interpretation of conductivity data; relation of conductance to total solids; relation of electrical conductivity of water to concentration of individual ions and to aggregate dissolved solids. Bibliography.

ATLANTA, GA. Treatment Methods of Atlanta, Ga., N. N. Wolpert. *Water Works Eng.*, vol. 93, no. 9, Apr. 24, 1940, pp. 558–564 and 572. Description of appliances developed, studies being made, and practices followed at water treatment plant of Atlanta, Ga.; application of activated carbon; pH checks; clay used for quick settling; wearing quality of pipes; features of Atlanta turbidimeter.

CHLORINATION. Break-Point Chlorination for Taste Control, W. J. Orchard. *Eng. News-Rec.*, vol. 124, no. 15, Apr. 11, 1940, pp. 91–92. New technique involves application of chlorine to predetermined dose, at which point change of condition will occur, resulting in sudden drop of residual content followed by breakdown of taste-producing substances; this development and method of automatic chlorination described.

CHLORINATION. Handling of Chlorine at Water and Sewage Plants, J. B. Baty. *Water & Sewage*, vol. 78, no. 4, Apr. 1940, pp. 24–25 and 66–69. Suggestions for avoiding operating troubles in chlorination of water and sewage; solubility of chlorine in water; condensation difficulties caused by uneven temperatures; temperature pressure curve of liquid chlorine; handling chlorine leaks; chlorine accidents; first-aid suggestions.

CHLORINATION. Simple Chlorine Deficiency Alarm, H. O. Johnson and F. M. Jablon. *Water Works & Sewerage*, vol. 87, no. 3, Mar. 1940, p. 135. Description of Belgrave chlorine deficiency alarm serving to notify operator in charge that chlorine cylinder has run out.

CHLORINATION. "Super-Super" Chlorination, H. A. Brown. *Water Works & Sewerage*, vol. 87, no. 4, Apr. 1940, pp. 146–151. Experience of water works of Ottumwa, Iowa, in combating unusual temporary contamination of water supply with chlorine dosages as high as 112 ppm.

FILTRATION PLANTS, CHICAGO. Double-Deck Settling Basins, L. D. Gayton. *Eng. News-Rec.*, vol. 124, no. 15, Apr. 11, 1940, pp. 98–100. Chicago's water filtration plant under construction includes two-story settling and coagulation basins; story of why this type of design was chosen and how tanks will operate.

FILTRATION PLANTS, CHICAGO, ILL. World's Largest Filter Plant, L. D. Gayton. *Water Works Eng.*, vol. 93, no. 8, Apr. 10, 1940, pp. 438–443. Design and construction of South District Filtration Plant of Chicago, Ill., which will handle peak-hour demand of 450 mgd; water flow through plant; recarbonating chamber; baffle chambers; coagulating and settling basins; filter beds; sodium silicate treatment.

FILTRATION PLANTS, ROCKPORT, MASS. Filtered Water for Rockport, E. S. Chase. *Water Works Eng.*, vol. 93, no. 8, Apr. 10, 1940, pp. 459–460. Design and construction of 1-mgd water filtration plant for Rockport, Mass., featuring aerated mixing tank, three chemical feed machines, coagulation tank with mechanical mixing paddle, etc.

LA GRANGE, ILL. Lime-Zeolite Softening Plant, L. R. Howson. *Water Works Eng.*, vol. 93, no. 8, Apr. 10, 1940, pp. 424–426 and 484. Problems in design and operation of new water-softening plant of La Grange, Ill., serving population of 12,000; lime feeding; mixing, settling, carbonation; zeolite filters; operating results; trouble with CO_2.

MANUAL. *Manual of Water Quality and Treatment*, Prepared and Published by American Water Works Assn., New York, 1940. 294 pp., illus., diagrs., charts, tables, $3. Manual represents prevailing views of water works managers and specialists concerning quality and treatment of water supplies; review of organisms that occur in water, methods of removal in use, treatments to remove tastes and odors, and methods of conditioning water chemically discussed. Bibliography. Eng. Soc. Lib., New York.

OZONE. Ozone Goes to Work, F. H. Dechant. *Eng. News-Rec.*, vol. 124, no. 15, Apr. 11, 1940 pp. 86–87. To meet special problem in taste and odor control, Denver, Pa., installed ozone treatment; description of plant includes information on novel type of ozone diffuser.

RAYON PLANTS. Noteworthy Advance in Water Conditioning Practice. *Rayon Textile Monthly*, vol. 21, no. 2, Feb. 1940, pp. 117–119. Details pertaining to water conditioning provisions at Painesville (Ohio) plant of Industrial Rayon Corporation.

RESERVOIRS, ALGAE CONTROL. Sun Ray Counts Save Sulphate, R. F. Goudey. *Eng. News-Rec.*, vol. 124, no. 15, Apr. 11, 1940, pp. 95–97. It is claimed there is no direct relationship between increased algae growths and high water temperatures; but author has discovered relationship based on measurements of ultra-violet radiations from sun; records prove that this unique approach to algae control in reservoirs has paid annual dividends of $5,000 in chemical savings.

SOFTENING, ZEOLITE PROCESS. Recent Experiences with Carbonaceous Zeolites, S. B. Applebaum. *Am. Water Works Assn.—J.*, vol. 32, no. 4, Apr. 1940, pp. 583–592. Review of experience of manufacturers of raw water ice, carbonated beverages, and of steam boiler users with actual carbonaceous zeolite installations; modern practice in feedwater conditioning; permutit degasifier. Bibliography.

TASTE AND ODOR REMOVAL. Taste and Odor Control at Dallas, L. C. Billings. *Am. Water Works Assn.—J.*, vol. 32, no. 4, Apr. 1940, pp. 613–620. Report on author's recent experience at Dallas, Tex., in control of tastes and odors by adsorption with carbon and adjustment of chlorine-ammonia ratio; threshold odors at treatment plant.

TASTE AND ODOR REMOVAL. Taste and Odor Treatment, N. J. Howard. *Water Works Eng.*, vol. 93, no. 8, Apr. 10, 1940, pp. 420–423 and 491. Review of development of taste and odor treatment of water supplies since 1925; causes for taste and odor; superchlorination for algae; value of chloramines; carbon doses; cost of treatment.

TASTE AND ODOR REMOVAL. Water-Treatment Problems, J. B. Baty. *Water & Sewage*, vol. 78, no. 2, Feb. 1940, pp. 19–20 and 49–50. Review of modern practice in taste and odor elimination by superchlorination; theory of superchlorination; demonstration at Toronto; methods of dechlorination; rates of application.

WATER BACTERIOLOGY. Induced Slow Lactose Fermentation in Escherichia Coli, M. E. Caldwell. *Am. Water Works Assn.—J.*, vol. 32, no. 4, Apr. 1940, pp. 659–690. Preliminary report on investigation of certain phases of oligodynamic action of copper on Escherichia coli.

YPSILANTI, MICH. Municipal Softening Plant Using Lime and Soda Ash, T. R. Kendall. *Am. City*, vol. 55, no. 3, Mar. 1940, pp. 44–45 and 81. Methods and special equipments used in softening and reducing iron content of water supply of Ypsilanti, Mich.; mixing and coagulation; filtration; recarbonization equipment; chemical treatment.

WATER WORKS ENGINEERING

INTAKES. Water Works Intakes, N. G. McDonald. *Am. Water Works Assn.—J.*, vol. 32, no. 4, Apr. 1940, pp. 661–674. Review of Canadian practice in design and construction of water works intakes; locating intake; planning conduits; using wells for discharge from intakes.

MANAGEMENT. Water Conservation Program on Vast Scale. *Am. City*, vol. 55, no. 4, Apr. 1940, pp. 55–59. Review of publicity methods and other measures adopted by Department of Water Supply Gas and Electricity of New York City for reducing water consumption during current drought.

ROUMANIA. Die Trinkwasserversorgung der Stadt Bukarest, L. Stanisavlievici. *Gas u. Wasserfach*, vol. 83, no. 5, Feb. 3, 1940, pp. 55–57. Historical review of development of water works of Bucharest, capital of Roumania, since 1880, with special reference to recent developments; chemical and bacteriological analyses of Bucharest drinking water.

Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

Arc Welding Handbook

Each year the "Procedure Handbook of Arc Welding Design and Practice" is reissued to include all new data essential for the most efficient use of arc welding. The Sixth Edition, just announced by the Lincoln Electric Co., Cleveland, O., contains 1,125 pages and 1,557 illustrations.

Encyclopedic in scope; written especially for use of designers, engineers, production managers, welding supervisors and operators, the Handbook contains a wealth of data of interest to steel fabricators and erectors, draftsmen, cost estimators, maintenance men and shipbuilders.

The eight sections of the book cover:

- Part I—Welding Methods and Equipment
- Part II—Technique of Welding
- Part III—Procedures, Speeds and Costs for Welding Mild Steel
- Part IV—Structure and Properties of Weld Metal
- Part V—Weldability of Metals
- Part VI—Designing for Arc Welded Steel Construction of Machinery
- Part VII—Designing for Arc Welded Structures
- Part VIII—Typical Applications of Arc Welding in Manufacturing, Construction and Maintenance

The Procedure Handbook is $5^3/_4 \times 9$ in., bound in dark blue semi-flexible simulated leather, gold embossed. Copies will be mailed, post paid, in the United States for $1.50; foreign, $2.00 per copy.

Pumpcrete Practice

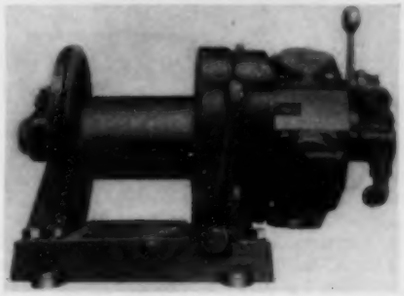
A MANUAL OF concrete placement by Pumpcrete method has just been published by Chain Belt Co., Milwaukee, Wis. Extensive research and thorough study of operations, machines, and methods were required to compile all of the examples, cost estimates, and data contained in the 96 pages, $8^1/_2$ by 11 in., of this manual, Bulletin 375.

The book deals with the placement of concrete on construction jobs involving around 1,000 yds of concrete and over. It is liberally illustrated with photographs and schematic drawings of typical and unusual concrete construction jobs on bridges, viaducts, buildings, sewage plants, locks and dams, tunnels, and many other kinds of structures. Also included are comparisons of various methods of concrete placement together with cost analyses of their use on various types of work. Distribution methods, concrete mixtures, mixing plants, and other important data necessary in figuring a concrete job are presented simply and graphically in a manner easily understood.

Since this is the only published book covering Pumpcrete methods in such complete fashion, it represents a reference work of value to designers and contractors.

Air Motor Feature of Hoist

"SMOOTHER TORQUE than a straight 8" is what Gardner-Denver officials say about the five-cylinder, radial air motor used to power their new line of single and double drum air hoists. Although the motor is new on air hoists, it has been proved in use on Gardner-Denver Mine Car Loaders.



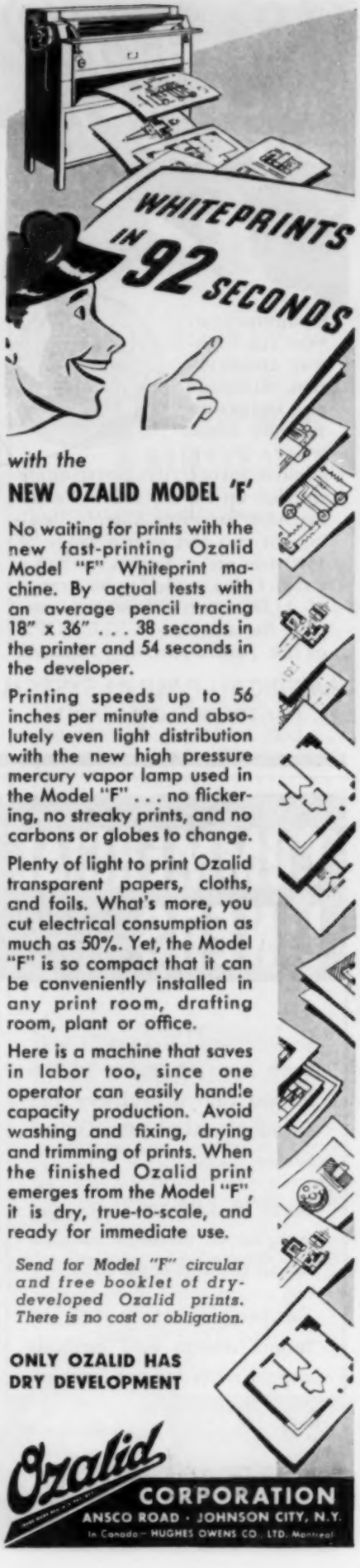
As described in the new Gardner-Denver Bulletin H-1, the new hoists have smaller overall dimensions and less weight per hp delivered than any other hoists of their type. They are very well adapted to hoisting, hauling, dragging, or scraping in mines, quarries, highway, and construction work, bridge erection and industrial plants. Other features which distinguish these hoists are safety design which makes it impossible to drop a load accidentally—powerful brake bands with conveniently located operating lever—hardened gears running in oil—entirely sealed gear train—3 points of lubrication care for all moving parts—throttle lever is self-centering with automatic safety latch to hold it in neutral position. Gardner-Denver Co., Quincy, Ill.

Small Sewage Sprinkler

THE "SIMPLETTE" Sprinkler for use in connection with small sewage purification plants is designed to apply settled sewage to a percolating filter. The sprinkler consists of a rotating distributing arm of channel section from which the sewage is fed to the filter by a series of "V" notches, spaced to assure even distribution. The rotating trough is actuated by means of bevel gearing and a water-wheel, and is supported by a box section beam which also conveys the sewage to the center of the rotating trough.

The manufacturer states that in conjunction with a septic tank or other form of settling tank, the "Simplette" Sprinkler will deal with the sewage from isolated groups of houses, schools, hospitals, and other institutions and give perfect purification on open or covered filters.

Descriptive literature and complete details will be sent by Yeomans Brothers Co., 1433 Dayton St., Chicago, Ill.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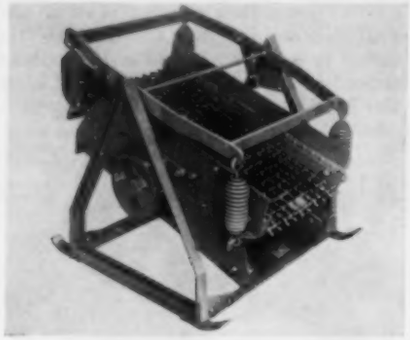
Vibrating Screen

THIS SCREEN is a small, light, inexpensive, portable, double deck, vibrating machine that will make separation of crushed stone, gravel, or sand into three sizes at about 100 tons per day. It is driven at 1,000 rpm by a 2-hp gasoline engine or a 1-hp electric motor. The width of the screening surface is 16 in. and the length 36 in. and the total weight less than 400 lb.



Its uses are for roadside construction plants, building construction, separation of sand for concrete blocks, bridge abutments, foundations, or other concrete work. It is equally effective for the sizing of cinders, coke, coal, or any other bulk material. The total cost of operation and maintenance, including interest on investment and depreciation, is reported by the manufacturers to be less than $^3/_4$¢ per ton of material. Robins Conveying Belt Co., Passaic, N.J.

For more than forty years, Robins Conveying Belt Company has maintained its executive offices in the old Park Row Building in New York. The factory is located at Passaic, New Jersey, where the company has now built a three-story brick office building to house its Executive, Engineering, Sales, and other Departments. Here they can be in closer touch with the manufacturing facilities to the advantage of clients, as well as themselves. The New York Sales Office address is 70 Pine St.

Small Portable Printer

THE ELPRO Portable Printer, sold by the Ozalid Corp., Johnson City, N.Y., has been developed for applications where occasional prints are required. It will make positive type reproductions in sizes up to 12 × 18 in. of engineering drawings, maps, reports; in fact, of any pencil or ink lines, typewritten or printed matter appearing on one side of a reasonably translucent material.

Exposure is made by six specially designed lamps, operating on an ordinary lighting circuit, 110 volts AC or DC. A time release switch allows the operator to automatically regulate exposure. The printing operation requires from two to three minutes, depending upon the type of original used, and dry development takes between three and five minutes. As many as seven or eight prints can be developed simultaneously.

Small Sewage Plant Units

FOR THE SMALL sewage plant the Chain Belt Co., Milwaukee, Wis., has developed a mechanically cleaned bar screen, grit collecting equipment, and a conveyor sludge collector.

A streamlined, completely housed replica of the large Rex mechanically cleaned bar screen is now available for the small plant. Built as a self-contained unit, it is of simple, rugged design and is easily installed in new or existing channels with a maximum width of 3 ft and a maximum depth of 5 ft. The screen may be used with or without the Rex Triturator.

A grit collector unit developed by the Chain Belt Co. puts mechanical grit removal equipment within the reach of the small plant budget. The new Rex unit is suitable for flows up to about 4 M.G.D. and is installed in a simple concrete channel with all machinery above the channel enclosed in a neat housing. Careful hydraulic design and grit washing by an ingenious recirculation arrangement, it is reported, assures grit of good quality for easy disposal.

The new Rex conveyor sludge collector embodies all the familiar features of the standard heavy equipment, but with parts proportionally smaller. Motorized drive units, self-cleaning bearings, pivoted scrapers, steel wearing shoes, and corrosion-resisting chain are incorporated in the design. A self-propelled automatic skimming device is also available to work in conjunction with the clarifier. Primary or secondary tank collectors can be furnished. The use of this equipment in tanks up to 10 ft in width by 50 ft in length is recommended by the manufacturer.

Athey Mobiloader

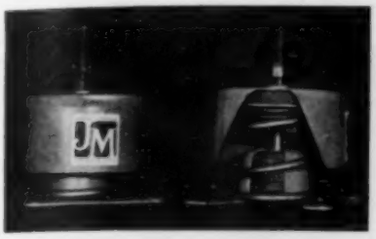
THE NEW ATHEY Mobiloader is a utility loading tool for mounting on a "Caterpillar" Tractor. It was designed for use by contractors—state, county, city, and township highway departments, and for a variety of industrial plant uses. To mount the Athey Mobiloader no changes are necessary either in new "Caterpillar" Diesel Tractors or in corresponding models of "Caterpillar" Tractors now in use. No special mountings of any kind are needed, and no holes need be bored.

The Mobiloader has a $1^1/_2$-yd bucket. There is 7 ft 6 in. clearance under the chute for rear dumping. For front dumping the load can be discharged at any point from the ground to a height of 7 ft 6 in. The device is cable operated, and is a ball-bearing mounted, worm-gear transmission unit. Control is from the tractor seat, and is unusually simple—one lever controlling all rear dumping, and front dumping being obtained with a simple adjustment.

In operation, the Mobiloader dumps to the rear without the necessity of maneuvering or turning the tractor in any way—a feature which is said to be unique among loading devices of its kind. Complete data from Athey Truss Wheel Co., 5631 W. 65th St., Chicago, Ill.

Machine-Vibration Isolator

A NEW, EASILY installed vibration isolator, designed to economically control machine vibration and reduce the resulting noise, was recently announced by Johns-Manville. The device, known as the J-M Controlled Spring Isolator, was developed for use on the bases of motors, generators, pumps, ventilating fans, and similar equipment where vibration and excessive motion create noise, tend to wear out machine parts, and connections.



The working parts of the unit consist of a coil spring and a rubber load pad, which support the equipment and isolate vibration, and an adjustable rubber snubber inside the base, which controls excessive motion. The isolator is made in two sizes: Light Duty, for loads from 60 to 190 lb per isolator; and Heavy Duty, for loads from 250 to 720 lb per isolator. The loaded overall dimensions of the isolator are 6 in. × 6 in. by approximately 3¾ in. high. It is enclosed in a metal jacket which protects the rubber parts from oil and light.

Two-Stage Pumps

FAIRBANKS, MORSE & CO., of 600 S. Michigan Ave., Chicago, Ill., announces a line of two-stage, split-case pumps with capacities up to 550 G.P.M. at heads ranging up to 600′ T.D.H. These units are suited to all classes of general pumping service where the liquid is of low viscosity and free from foreign matter; for water supply to high buildings, small municipalities, industrial plants, etc.

The line incorporates numerous features. One-piece impellers are mounted "back to back" on the shaft to assure proper hydraulic balance. Removable wearing rings with streamlined water guiding surfaces are provided on both casing and impeller. The shaft, made of high manganese alloy steel, is journaled in ball bearings of ample size to withstand all thrust and radial loads. Horizontally divided bronze glands facilitate removal and adjustment of packing. A bronze water seal ring for clear water in the stuffing box on the low pressure stage prevents air from entering the pump chamber and reducing efficiency. The compact casing is horizontally divided so the upper casing may be lifted to expose the rotating element.

Fairbanks-Morse two-stage pumps are supplied as basic units, and also as base-mounted units direct-connected to electric motors or steam turbines. Bulletin 5972 describes these pumps more completely.

Concrete Paving Spreader

A PAVING SPREADER recently introduced by Blaw-Knox Co., Pittsburgh, Penna., is already in service in Pennsylvania and Texas, where it is reported to have produced better than 300 linear ft of slab 12 ft wide by 9 in. thick, two course work per hr.

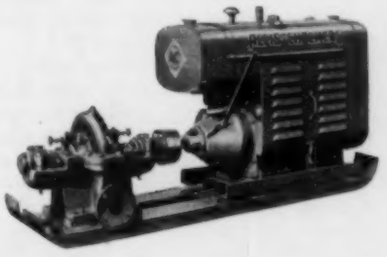
The key feature of the machine is a spreading blade which does its work much as a mason spreads mortar with a trowel. The blade moves the concrete forward as well as spreading it laterally. This spreading operation is automatic and all parts of the road bed are filled to proper thickness and grade. Both the spreading blade and strike-off plate are quickly adjustable for levels below the forms to accommodate laying the steel mesh in two course work. The spreader can also be furnished with a vibrator attachment for vibrating both courses. When so equipped, the strike-off plate and vibrator are a composite unit.

The machine is driven through an automatic type unit transmission. It is provided with three speeds for both reverse and forward travel, 11, 20, and 122 ft per min on machines up to 14 ft wide; and 8, 14, and 90 ft per min on wider machines. A recent bulletin completely describes this new spreader.

Engine Driven Pumps

TO PROVIDE independently powered pumps for drainage, irrigation, construction jobs, and similar applications, the Allis-Chalmers Mfg. Co. has introduced a line of centrifugal pumps driven by gasoline power units.

Power units in five sizes (18 to 110 hp) assure economy in operation with a choice of fuels: gasoline, kerosene, distillate, natural gas, or butane. All power units have valve-in-head medium speed engines, with removable cylinder liners, efficient cooling systems, force feed lubrication, and a variable speed governor.



The centrifugal pumps are horizontal shaft, single stage, single or double suction pumps designed for handling liquids at normal temperatures with maximum efficiency. To facilitate handling, the engines and pumps are mounted on a base and are available in many combinations to meet various requirements in quantity and pressure up to 5,000 gal per min and 100 ft head.

A folder (Form MS 253) describing these engine and pump units may be obtained from the Tractor Division, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

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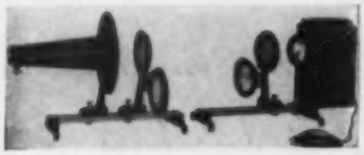

To the machine designer, photoelastic stress analysis is not only of value in the verification of calculations based on theoretical solutions, but also in the solution of problems where theoretical analysis is not available. Where weight and space must be conserved actual stress distribution is more important than stress indicated by theoretical analysis.

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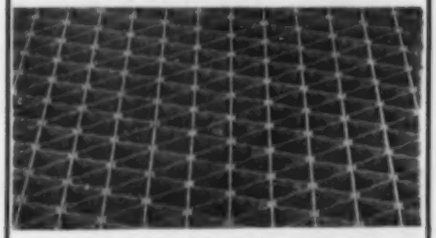

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Building Utilizes Strength of Steel Panels

A NEW TYPE of prefabricated, all-steel industrial building, in which structural strength and rigidity are attained by pulling the steel panel sheets into tension between the framing members, is Lindsay Structure of Dry-Zero Corp., Chicago, Ill.

The new Lindsay Structure principle represents a definite break from traditional methods of putting steel together into industrial buildings. In this structure, the sheets are "pre-tensed" to resist the slightest move of the framing, and the load is distributed over their entire area. This is done by means of a patented flange and tensioner which creates a union between sheets and framing that approximates the full strength of the sheet. With this construction, therefore, it is possible to use lighter gage sheets and lighter framing, usually with a marked gain in strength.

Lindsay Structure can be used to make general industrial buildings, pump houses, meter houses, warehouses, contractors' shacks, freight houses, loading docks, and other structures.

Literature Available

CALCIUM CHLORIDE—The place of calcium chloride in concrete is conservatively described in a five-section, 48-page booklet entitled, "Calcium Chloride and Portland Cement." The sections cover Facts and Figures; Practical Use; Questions and Answers; Abstracts and References; and Specifications. Solvay Sales Corparation., 40 Rector St., New York, N.Y.

CHEMICAL FEEDERS—A new bulletin, No. 350-A, describes Infilco chemical mixers and feeders for the uniform preparation and feeding of suspensions or solutions in water, sewage and process liquid conditioning and in other applications. International Filter Co., 325 W. 25th Place, Chicago, Ill.

CONCRETE MIXERS—Four new bulletins describe and thoroughly illustrate the 1940 line of Rex Concrete Mixers. Bulletin No. 360 covers the Rex 3½ S, a tilting mixer. Bulletin No. 361 features the Rex 5-S and 7-S Mixers, made in two or four wheel, end or side discharge models. The Rex 10-S and 14-S mixers with their new retractable outriggers and adjustable towing poles are described in Bulletin No. 362. "Rex Big Mixers for Modern Mixing Plants" is Bulletin No. 363. Chain Belt Co., Milwaukee, Wis.

CONCRETE VIBRATORS—The complete line of vibrators, pneumatic and electric, is described in Bulletin SP 1955. Three new vibrators are included. Chicago Pneumatic Tool Co., 6 E. 44th St., New York, N.Y.

CRUSHERS—Jaw crushers, in a range of 10 sizes, are featured in Bulletin D-40 D, with illustrations and dimension tables. Diamond Iron Works, Inc., Minneapolis, Minn.

ELECTRICAL EQUIPMENT—The new 64-page enlarged April 1940 edition of the "Quick Selector" catalog, prepared especially to facilitate the user of electrical equipment in selecting the correct apparatus for any motor, lighting, or feeder circuit, is available from department 7-N-20, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penna.

EXPLOSIVES—The catalog, "Atlas Explosives" covers the entire line and includes specifications on all necessary blasting accessories. Atlas Powder Co., Wilmington, Del.

MOTOR GRADERS—The mechanical features and capacities of The Caterpillar 12 in. series of motor graders have been described in Booklet, Form 5731. It covers all details of the No. 12, No. 112, and No. 212 machines. Caterpillar Tractor Co., Peoria, Ill.

MOVABLE WALLS—a new 20-page illustrated brochure, "Transite Movable Asbestos Walls," was recently announced by Johns-Manville. Included in the book are case histories of installations, construction details, and specifications, as well as descriptive information on movable walls for sub-dividing offices, factories. Form TR-22A. Johns-Manville, 22 East 40th St., New York, N.Y.

NICKEL ALLOYS—A sixteen-page, pocket size publication, "Seven Minutes With Seven Metals," includes material on Nickel, Monel, Inconel, and associated alloys in mill, clad, and cast forms. Three pages are devoted to detailed tables on mechanical, chemical, and physical characteristics. The International Nickel Co., 67 Wall St., New York, N.Y.

PUMP SELECTION TABLES—By including complete selection tables, typical specifications, and principal dimensions, in their pump bulletins, Fairbanks, Morse & Co. have simplified the problems of the engineer selecting pumping equipment. Recent bulletins, on Builtogether pumps, centrifugal pumps, and sewage and trash pumps, have been prepared in this manner. Fairbanks, Morse & Co., 600 S. Michigan St., Chicago, Ill.

STEEL—A two-color, 40-page catalog, Form 353, on Republic Double Strength Steel, a high tensile, low alloy product, covers resistance to corrosion and fatigue, fatigue limits, welding qualities, service records, and fabrication. Advertising Division, Republic Steel Corp., Republic Building, Cleveland, Ohio.

TIDE GATES—A new bulletin, No. A-66 describing their rectangular and circular tide gates, with dimension tables, has been issued by Brown & Brown, Inc., Lima, Ohio.

WELDING—All items of equipment and fittings for welding and cutting are included in the Victor 1940 Catalog. Victor Equipment Co., 844 Folsom St., San Francisco, Calif.

WIRE ROPE—A pocket size booklet of wire rope for road building equipment carries a folded table of recommended wire rope lines for uses on specific equipment. Hazard Wire Rope Division, American Chain & Cable Co., Inc., Wilkes-Barre, Penna.